POWER

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IF WE COULD HAVE OUR WAY!

The Moline Power Plant

By Thomas Wilson

SYNOPSIS—From belt drive to a modern plant having a capacity of 21,500 kw. Its features are special coal chutes, individual steel stacks, the latest type of impulse-reaction turbine and a double-unit arrangement of metering heater and metering dividing box.

The Moline power station of the Tri-City Railway & Light Co., which is controlled by the United Light & Railways Co., has undergone a rapid evolution from the simplest kind of plant to a modern power station of magnitude. It is at the foot of Fourth St., on the banks of the Mississippi River, at a narrow passage between the main land and Sylvan Island. At this point, a water power having an average head of about 10 ft. had been developed and it has always been run in conjunction with the steam plant.

About a dozen years ago, the station was equipped with cross-compound engines turning by rope drives a line shaft running the length of the station. The shaft was also turned by a rope drive running over a 250-ft. bridge to the watersheds. Naturally, the generators were belted to the line shaft and the jet condensers serving the engines were also belted units. The boilers were hand fired and there was no coal-handling machinery to reduce the labor in this department. The belted units were gradually discarded, the rope drive from the water-power plant was taken out and generators were attached to the waterwheels; new boilers, equipped with stokers and superheaters, were installed and bucket conveyors handled the coal and ash.

In 1908, at the time this plant was described in Power, there were eleven 500-hp. boilers, and in the engine room two 1000-kw. cross-compound condensing units directly connected to revolving field alternators and exhausting into vertical, double-acting jet condensers, one 1500-kw. and one 3000-kw. reaction turbine, one of the older units still connected to a small portion of the line shaft, and a couple of motor-generator sets.

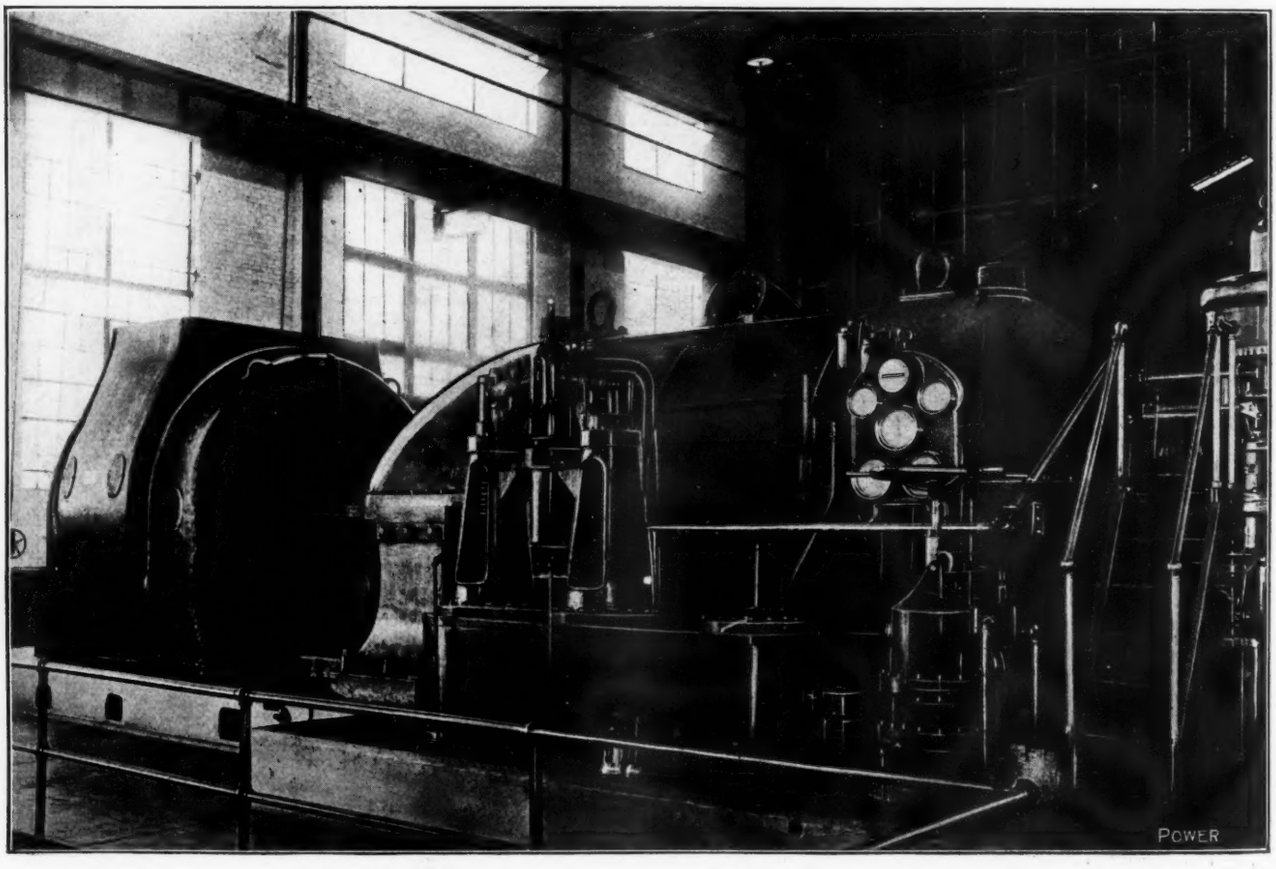


Fig. 1. The 10,000-Kw. Unit in the Moline Power Plant

Due to the rapid growth of the three cities, to the extension of the lines to Muscatine and to the small towns in the vicinity, the increase in the load was phenomenal. It soon passed the station capacity and in 1910 it was necessary to install a 6000-kw. turbine. The plant was nearly filled with generating equipment, but instead of enlarging the building, one of the cross-compound engines was removed to make way for the above unit and a 10,000-kw. turbine, Fig. 1, the latter being ready for operation by the first of last December. One of the large engine units, Fig. 8, still remains, but when the load requires it, this machine will be replaced by a second 10,000-kw. turbine. which will occupy less floor space

than the 1000-kw. engine and develop ten times the power at a much lower steam rate.

At present, the plant has a total boiler capacity of 7900 hp., and, at rating, 21,500 kw. in generating units, making a ratio of 1 to 2.7, respectively. The low steam rate of the large turbine units has lessened the demand on the boilers. Last winter the load in the steam plant

FIG. 2. FIRING AISLE OF THE BOILER ROOM

ran about 135,000 kw.-hr. per day of 24 hr., in the water plant 30,000 kw.-hr. per day and the same at the Sears plant, which also belongs to the system. From 1 to 5 a.m., when the demand is light, the water plants, having an alternating-current capacity of 2750 kw. in three units and 500 kw. in a direct-current machine at Moline and 2100 kw. at Sears in six vertical units of 350 kw. each, carry the entire load.

In the three cities there is supplied by the company all of the lighting, street and interior, all of the current for street-railway service and 80 per cent. of the power

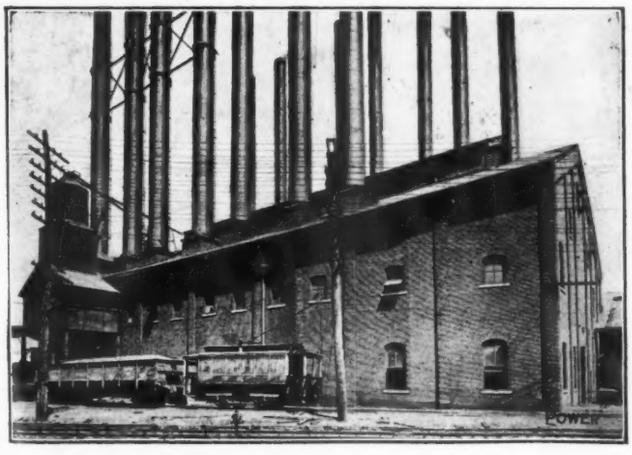


FIG. 3. A "FOREST" OF INDIVIDUAL STEEL STACKS

required in all the industrial plants, besides the service to the surrounding towns. The current is generated at 4800 volts, two-phase, 60-cycle. For nearby towns it is distributed at 4800 volts and for Muscatine, 30 miles distant, the voltage is 33,000. Ultimately, all transmission from the power house to the five substations will be at 33,000 volts. It is with the steam plant, however, that this article has to do. There are some interesting features in the boiler room, Fig. 2, the large turbine is of interest, and there is a special metering heater, the only one of its kind in the Central States.

BOILER ROOM

The equipment includes eleven 500-hp. and four 600-hp. water-tube boilers arranged in two rows and facing a central aisle. The operating pressure is 200 lb. gage, with 110 deg. of superheat. All of the boiler furnaces have chain grates.

Each boiler has an individual steel stack, Fig. 3, and although this practice was due to the frequent additions made, it is really in line with modern development. The tendency is to reduce the number of boilers served by one stack, and in some of the most recent plants the number has been cut down to two. There is no breeching, and as the gases have a straight flow up into the stack, there is only the resistance of the setting to prevent getting the maximum draft over the fire. At the Moline plant, the individual stack is well liked. It gives independent control of each boiler, the initial cost as compared with an equivalent in four brick or concrete stacks is less, and

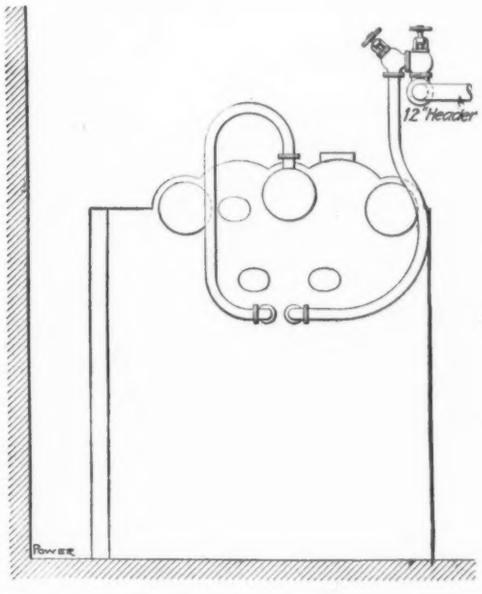


FIG. 4. TYPICAL BOILER CONNECTION TO HEADER

by painting at least every two years the steel stack is good for 15 to 20 yr. of service. One objection is the number of stacks. There are now fifteen, and with the increase in the boiler capacity expected in the near future, more will be needed if the same practice is followed. The steel stacks may then be replaced by four concrete chimneys of equivalent capacity.

The stacks have a uniform height of 150 ft. above the grates. Those for the smaller boilers are 5½ ft. in diameter and the four serving the 600-hp. units are 6 ft. in diameter, providing in each case 0.047 sq.ft. of area per horsepower of rating. The draft above the damper runs about 0.9 in. of water and reduces over the fire to 0.3 in. When burning Illinois screenings, a fuel bed 5 in. thick is carried. As received, the coal runs about 10,000 B.t.u. and an evaporation from and at 212 deg. or 7 lb. per pound of coal as fired, is obtained. On the present light

load, about 3½ lb. is required per kilowatt-hour, but with the heavy load next winter a reduction to 2½ lb. is expected.

Coal and Ash Handling

Coal delivered in railway cars is dumped into a hopper under the siding. A 22-in. belt carries it to either of two continuous bucket conveyors, of which there is one for each row of boilers. Both deliver into a sectionalized steel bunker which has 16 compartments and a total capacity of 1200 tons, situated over the firing aisle. Either conveyor will normally handle 50 tons per hour. There is provision for chuting into the conveyors the fine coal dropping through the grates.

From the bunker, the coal is chuted to the stoker hoppers, and in this connection trials have been made to secure a chute of proper form. The usual single spout arranged to swing from one end of the hopper to the other was first tried. As long as the gate was closed after filling the hopper, this type was satisfactory, but it was often left open and the pressure at the point at which the chute was resting caused a heavier feed on that portion of the grate in line with it; uneven burning of the fuel was the result. A flared chute, covering the entire hopper, was next tried, but in this the coal separated, the coarse pieces rolling to the outside and the fine coal feeding down the center. A Y-outlet gave the same results as the single spout only that the feed was forced in two places and it also separated the fine and coarse coal. It was replaced with a three-legged chute obtained by using a double lateral fitting. The results were still unsatisfactory until a baffle plate was inserted at the back of the hopper to take the weight of the coal and mix it as it came from the chute. With this last provision the chute is now foolproof. There is no occasion to swing it, nor is it necessary to shut the gate. The feed is continuous and no particular watching by the firemen is required.

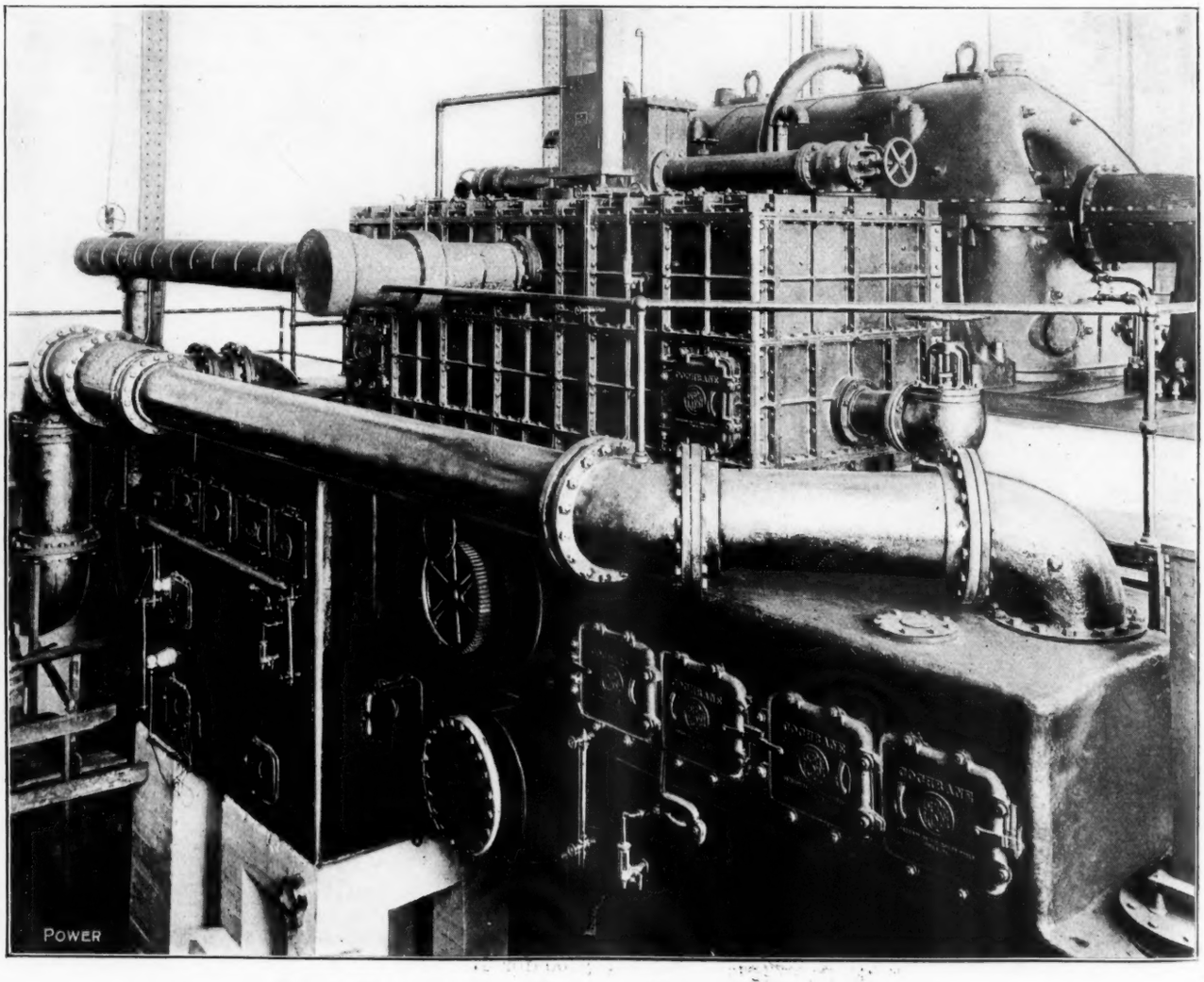


Fig. 5. Multiple-Unit Metering Heater and Dividing Box

Ashes are handled by a pneumatic system through an 8-in. pipe. The horizontal run along the ashpits is about 175 ft., the lift about 80 ft. and the run over the boiler-room roof to the separating tank about 100 ft. From the latter, the ashes are delivered to a bunker beside the railway track. In the horizontal pipe over the roof, water is introduced to kill the fire in the ash and eliminate clinkering in the separator or bunker. It also prevents dry ash reaching the blower.

The main header, which is made of steel to withstand the superheated steam, loops the coal bunker, passing over

the boiler fronts, Fig. 4. It is 14 in. on one side, 12 in. on the other and is so valved that it may be sectionalized every three boilers. The header is anchored at the four corners of the boiler room and a U-bend in each of the longer runs provides for expansion. Saturated steam from

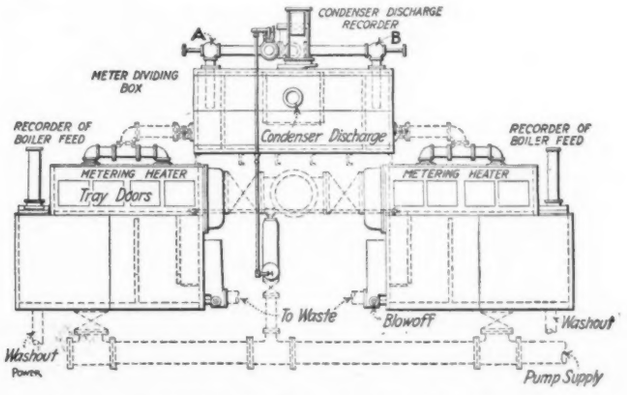


FIG. 6. LAYOUT OF HEATER AND CONNECTIONS

the boiler drum passes down to the superheater, entering through the side of the setting and, returning through a sickle bend which provides for expansion, it enters the header through an angle body, nonreturn valve and a straight-angle valve mounted directly in the header. Taps for the main units are carried over to the boiler-room wall, where they are dropped and pass to the various machines underneath the engine-room floor.

THE FEED WATER

To supply the feed water to the boilers, there are three 14 and 8¾ by 16-in. duplex pumps and one steam-turbine-driven centrifugal pump having a capacity against the boiler pressure of 450 gal. per min. Ordinarily, the centrifugal pump is used, or if this is down for any reason, the other three units. Duplicate 6-in. feed lines loop all the way around the boilers. They are liberally cross-valved and 2½-in. taps lead to the boilers. Condensate is collected in the heater from the hotwells of the various turbines, and the makeup comes from the oil cooler of the large turbine. This is virtually a surface condenser with straight tubes placed alongside the machine. The heat in the oil is thus utilized in the boiler feed.

A SPECIAL HEATER

The feed-water heater, Fig. 5, is of the recently developed multiple type. There are two metering heaters, each having a capacity to handle 300,000 lb. of water per hr., or a total of 600,000 lb. The dividing box, having a capacity of 500,000 lb. per hr., is arranged above the two heaters. Condensate from the condensers enters the central portion of the box and overflows through a V-notch on either side into the end compartments; the water is thus equally divided between the two heaters and an automatic recorder shows the amount. Makeup water is introduced into the end compartments through pipes *A* and *B*, Fig. 6. Here again the division is equal as a makeup-water dividing box equally divides an automatically regulated supply and distributes it to the outboard sides of the condensate dividing box. As the water enters the compartments directly, it is not metered. With the condensate, it passes to the heaters, where the total quantity fed to the boilers, which includes condensate, makeup water and the steam from the auxiliaries condensed, passes over the other weirs, a meter on each heater recording the amount. The difference between the sum of the heater readings and the reading of the meter on the dividing box represents the steam to auxiliaries, water lost by leakage, blowing down the boilers, etc. If it is desired to determine the water rate on an individual unit, it can be done with one heater and the dividing box, while the other heater is reserved for the balance of the plant. To conform with a 29-in. vacuum obtained on the large unit, the meter on the dividing box is calibrated for a water temperature of 80 deg. and those on the heaters for 210 deg.

GENERATING EQUIPMENT

The number and capacity of the generators were previously given; all, with the exception of the 1000-kw. engine unit, are turbine-driven. The smaller units are of the reaction type and were standard when installed, while the 10,000-kw. machine embodies the improvements which have attended the development of the larger turbines. The machine is of the combination impulse-reaction type divided into high-, intermediate- and low-pressure elements contained in the one casing. In the impulse or high-pressure element at the center of the machine, the steam is expanded from 200 to 80 lb. and, dividing equal-

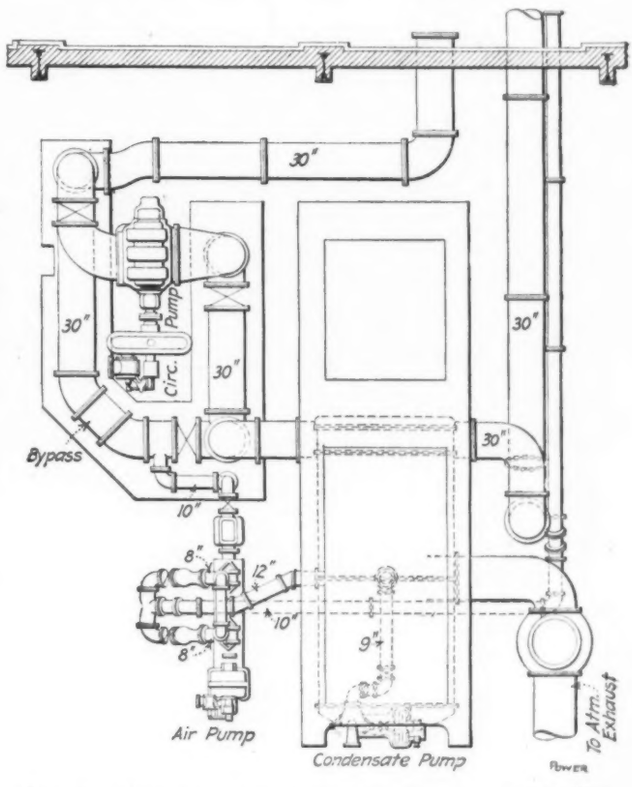


FIG. 7. CONDENSER AND AUXILIARIES OF 10,000-KW. UNIT

ly, passes in opposite directions through the intermediate blading to the low-pressure elements. The reaction end of the turbine is double-flow, with an exhaust outlet at either end of the machine. The primary valve is designed to carry 10,000 kw. and, with the help of the secondary valve, 15,000 kw. To improve the economy of the ma-

chine when the load is between 10,000 and 12,500 kw., a hand-operated nozzle supplementary to the primary valve has been provided. It is thus possible to develop 12,500 kw. before the secondary valve is called into service.

The water rate guaranteed for the machine was 13.7 lb. per kw.-hr. at 200 lb. initial pressure, 100 deg. superheat and a 28-in. vacuum. As a matter of fact, at two-thirds load, an absolute pressure of ½ in. was maintained and at full load a vacuum of nearly 29 in. The rate is known to be better than the guarantee, but no definite figures are available. On a similar unit, a rate of 12.8 lb. per kw.-hr. at 28-in. vacuum has been obtained, and with 29 in. this was reduced to 12.5 lb.

The supply pipe is 14 in. in diameter. At normal load and a rate of 13.7 lb. per kw.-hr., this would call for 137,000 lb. of steam per hour. As the pressure is 200 lb. gage and the superheat at the turbine 100 deg., this is equivalent to 345,240 cu.ft. per hr. or 5754 cu.ft. per min. The velocity would be approximately 5200 ft. per min., and with the secondary valve open, it would increase to 8000 ft. per min. At 28 in. of vacuum, the exhaust is discharged through the outlets at a rate of 14,000 ft. per min.

The condenser, which is immediately under the turbine, is of the surface type, with ample spaces through the tube sections for the free passage of the steam and with two inlets to match the turbine-exhaust openings. The drop through the condenser is only 0.08 in. It contains 19,000 sq.ft. of surface in 1-in. tubes, which gives a ratio of 1.9 sq.ft. to every kilowatt of turbine rating. To condense the 137,000 lb. of steam per hour, 9,500,000 lb. of water (a ratio of 70 to 1) is passed through the condenser. This amount is maintained constant and the vacuum allowed to vary slightly. As a reason for this practice, the circulating water is drawn from the river just above the dam. As the tailrace into which the water is discharged is 10 ft. lower, it is necessary to use the circulating pump only to start the flow. When it has been established, the siphoning action due to the difference in head will maintain it. As there is bypass connection around the pump, it is a simple matter to change over.

A Leblanc air pump, driven by a 100-hp. turbine, and having a capacity of 960 cu.ft. per min., is used. Of water, 1600 gal. per min. is required, and as its temperture is only raised ½ deg., it could be used in the condenser or recirculated through the pump with a little makeup to keep down the temperature. In the present plant, there is plenty of water so that the discharge from the pump is returned to the river.

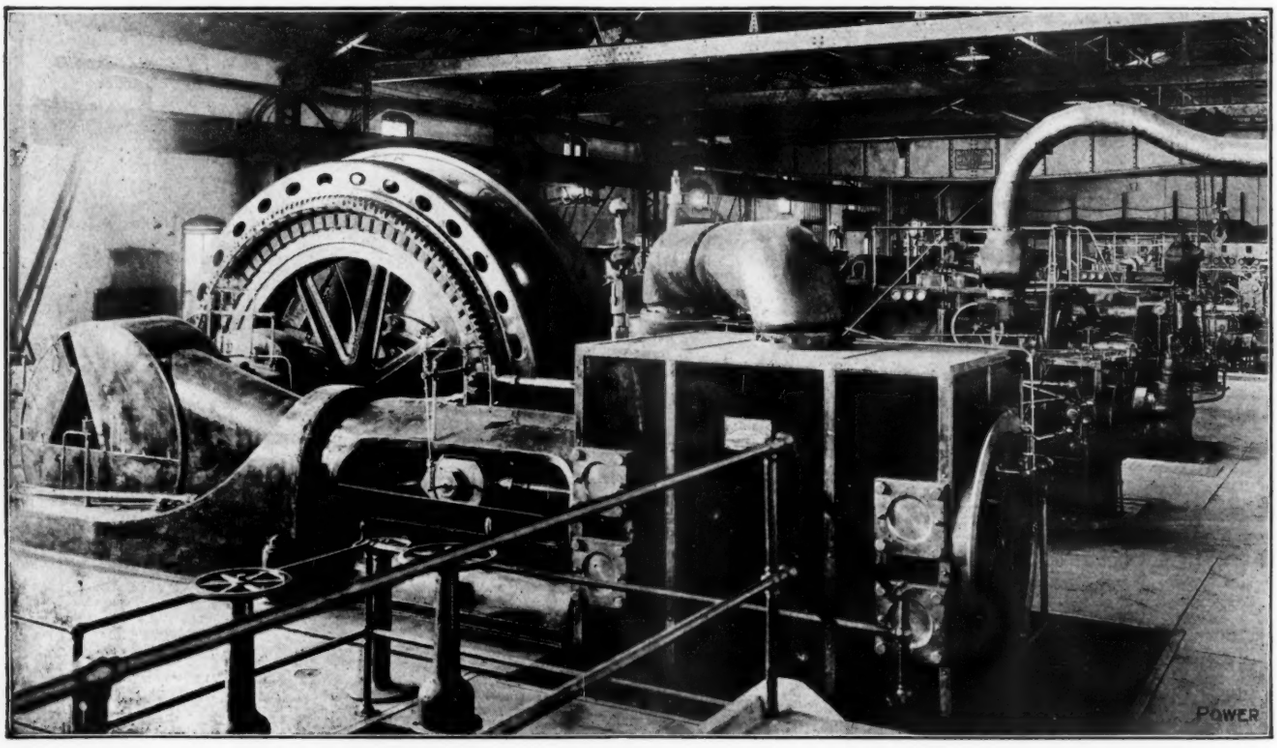


FIG. 8. COMPOUND ENGINE UNIT AND THE SMALL TURBINES

The circulating pump, which is used only at starting, has a capacity of 20,000 gal. per min., and is driven by a 175-hp. turbine. The condensate pump is a single-stage centrifugal, driven by a 25-hp. turbine; its capacity is 900 gal. per min. All of the auxiliaries for the large unit are of the rotary type and are driven by steam turbines. The same is true of the 6000-kw. machine, with the exception of the air pump, which is a direct-acting piston pump. For the two smaller turbines, the circulating pumps are centrifugal and engine driven. The air pump for the 1500-kw. unit is of the double-acting, valveless-suction type, while the air pump on the 3000-kw. turbine is a single-acting triplex pump of the same type.

It is needless to say that all of the condensers for the turbine units are of the surface type, while the 1000-kw. Corliss has a vertical double-acting jet condenser capable of maintaining a vacuum of 27 in. On the two smaller turbines the vacuum averages about 28 in. and on the

6000-kw. turbine, 28½ in. For the latter the condenser has 18,800 sq.ft. of surface, or 3.13 sq.ft. per kilowatt of rating. Of the other two, the larger has 10,000 sq.ft. of surface as compared with 4000 sq.ft. for the condenser serving the 1500-kw. turbine. This gives 3⅓ and 3⅔ sq.ft. per kilowatt of turbine rating, respectively. Fig. 7 shows the layout of the condenser and auxiliaries of the 10,000-kw. unit.

The steam rates for the smaller units are naturally higher than for the machine recently installed. The accompanying table will, however, reduce the condensing equipment of the four turbine units to a basis of steam condensed per square foot under the present conditions of pressure and superheat, the vacuum to be 28 in. and the steam rate that obtained at normal load.

The steam consumptions are taken from the guarantees furnished at the time the machines were installed. It was not until after the 600-kw. unit had been put in service that the boilers were equipped with superheaters, so that the operating conditions were 175 lb. pressure and no superheat. With the 100 deg. of superheat now available and the increase of 25 lb. in pressure, the water rate

PRINCIPAL EQUIPMENT OF MOLINE POWER PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
11	Boilers	Stirling water-tube	500 hp.	Generation of steam	200 lb. pressure, 110 deg. superheat	Babcock & Wilcox Co.
4	Boilers	Stirling water-tube	600 hp.	Generation of steam	200 lb. pressure, 110 deg. superheat	Babcock & Wilcox Co.
15	Superheaters	Foster	465 and 550 sq.ft.	Superheat steam for turbines	Temp. steam, 500 deg. F	Power Specialty Co.
8	Stokers	Chain grate	100 sq.ft.	Boiler furnace	5-in. fuel bed, Illinois screenings	Green Engineering Co.
7	Stokers	Chain grate	110 sq.ft.	Boiler furnace	5-in. fuel bed, Illinois screenings	Illinois Stoker Co.
3	Coal conveyors	Belt	21 in. wide	Track hoppers to main conveyors	3300 ft. per min., 75 tons per hr.	C. W. Hunt Co., Inc.
3	Motors	Induction	5 hp.	Driving belt conveyors	440 volt, two-phase	Westinghouse Elec. & Mfg. Co.
1	Coal crusher		50 tons per hr.	Crush coal	Motor driven	C. W. Hunt Co., Inc.
1	Motor	Induction	10 hp.	Driving crusher	440 volt, two-phase, 850 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Coal conveyor	Pivoted bucket	50 tons per hr.	From belt conveyors to bunkers	400 ft. per min., 50 tons per hr.	Jeffrey Mfg. Co.
1	Motor	Induction	15 hp.	Driving conveyor	440 volt, two-phase, 850 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Coal conveyor	Pivoted bucket	50 tons per hr.	Belt conveyors to bunkers	420 ft. per min., 50 tons per hr.	C. W. Hunt Co., Inc.
1	Motor	Induction	15 hp.	Driving conveyor	440 volt, two-phase, 850 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Ash system	Pneumatic	9 tons per hr.	Removal of ash		Green Engineering Co.
1	Exhauster	Suction	16 in.	Vacuum on ash system	6 oz. vacuum, 3600 r.p.m.	General Electric Co.
1	Motor	Induction	50 hp.	Driving exhauster	440 volts, two-phase, 3600 r.p.m.	General Electric Co.
3	Pumps	Duplex	14x8½x16 in.	Boiler feed	200 lb. pressure	Epping-Carpenter Co.
1	Pump	Centrifugal	5 in.	Boiler feed	3000 r.p.m., 420 gal. per min.	Westinghouse Machine Co.
1	Turbine	Horizontal reaction	30 hp.	Driving feed pump	200 lb. pressure, 3065 r.p.m.	Westinghouse Machine Co.
1	Heater	Cochrane multiple unit	600,000 lb. per hr.	Heat boiler feed water	Exhaust from auxiliaries	A. Sorge, Jr., & Co.
1	Turbine	Impulse-reaction	10,000 kw.	Main unit	200 lb. pressure, 100 deg. superheat, 1800 r.p.m.	Westinghouse Machine Co.
1	Generator	Alternating current	10,000 kw.	Main unit	4800 volts, two-phase, 1800 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Condenser	Surface	19,000 sq.ft.	On 10,000-kw. unit	29 in. vacuum	Westinghouse Machine Co.
1	Air pump	Leblanc rotary	960 cu.ft. per min.	Air from condenser	2500 r.p.m.	Westinghouse Machine Co.
1	Turbine	Horizontal reaction	100 hp.	Drive air pump	200 lb. pressure	Westinghouse Machine Co.
1	Circulating pump	Single-stage centrifugal	20,000 gal. per min.	Water to condenser	1000 r.p.m.	Westinghouse Machine Co.
1	Turbine	Horizontal reaction	175 hp.	Drive circulating pump	200 lb. pressure, 1000 r.p.m.	Westinghouse Machine Co.
1	Condensate pump	Centrifugal	900 gal. per min.	Condensate to heater	200 r.p.m.	Westinghouse Machine Co.
1	Turbine	Horizontal reaction	25 hp.	Driving condensate pump	200 lb. pressure, 2000 r.p.m.	Westinghouse Machine Co.
1	Turbine	Horizontal reaction	6000 kw.	Main unit	200 lb. pressure, 100 deg. superheat, 1800 r.p.m.	Westinghouse Machine Co.
1	Generator	Alternating current	6000 kw.	Main unit	4800 volts, two-phase, 1800 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Condenser	Surface	18,800 sq.ft.	On 6000-kw. unit	28½ in. vacuum	Henry R. Worthington
1	Air pump	Direct acting	30x24 in.	Air from condenser	200 lb. pressure, 60 r.p.m.	Laidlaw-Dunn-Gordon Co.
1	Circulating pump	Centrifugal	24 in.	Water to condenser	785 r.p.m.	Henry R. Worthington
1	Turbine	Horizontal reaction	110 hp.	Driving circulating pump	200 lb. pressure, 785 r.p.m.	Kerr Turbine Co.
1	Condensate pump	Centrifugal	4 in.	Condensate to heater	1500 r.p.m.	Henry R. Worthington
1	Turbine	Horizontal reaction	20 hp.	Driving condensate pump	200 lb. pressure, 1500 r.p.m.	Kerr Turbine Co.
1	Turbine	Horizontal reaction	3000 kw.	Main unit	200 lb. pressure, 100 deg. superheat, 1200 r.p.m.	Westinghouse Machine Co.
1	Generator	Alternating current	3000 kw.	Main unit	4800 volts, two-phase, 1200 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Condenser	Surface	10,000 sq.ft.	On 3000-kw. unit	28 in. vacuum	C. H. Wheeler Mfg. Co.
1	Air pump	Mullan single-acting triplex		Air from condenser	75 r.p.m.	C. H. Wheeler Mfg. Co.
1	Engine	Simple vertical	12x10	Driving air pump	200 lb. pressure, 75 r.p.m.	C. H. Wheeler Mfg. Co.
1	Circulating pump	Centrifugal	18 in.	Water to condenser	400 r.p.m.	Morris Machine Works
1	Engine	Simple vertical	12x14 in.	Driving circulating pump	200 lb. pressure, 400 r.p.m.	Morris Machine Works
1	Turbine	Horizontal reaction	1500 kw.	Main unit	200 lb. pressure, 100 deg. superheat, 1200 r.p.m.	Westinghouse Machine Co.
1	Generator	Alternating current	1500 kw.	Main unit	4800 volts, two-phase, 1200 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Condenser	Surface	4000 sq.ft.	On 1500-kw. unit	28 in. vacuum	C. H. Wheeler Mfg. Co.
1	Air pump	Mullan steam driven, double-acting	8x18x12 in.	Air from condenser	200 lb. press., 80 r.p.m.	C. H. Wheeler Mfg. Co.
1	Circulating pump	Centrifugal	12 in.	Water to condenser	500 r.p.m.	The Blake & Knowles Steam Pump Works
1	Engine	Simple vertical	8x9 in.	Driving circulating pump	200 lb. press., 500 r.p.m.	The Blake & Knowles Steam Pump Works
1	Engine	Cross-compound	24x50x48 in.	Main unit	200 lb. pressure, 100 r.p.m.	Allis-Chalmers Co.
1	Generator	Alternating current	1000 kw.	Main unit	4800 volts, two-phase, 100 r.p.m.	Allis-Chalmers Co.
1	Condenser	Vertical double-acting jet	18x36x20 in.	On engine unit	27 in. vacuum	Dean Bros. Steam Pump Works
1	Exciter	Direct current	150 kw.	Excitation main units	125 volts, 250 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Engine	Simple	12x18 in.	Drive exciter	Noncondensing, 250 r.p.m.	Skinner Engine Co.
2	Exciters	Direct current	50 kw.	Excitation main units	Driven by water wheels	Westinghouse Elec. & Mfg. Co.
2	Exciters	Direct current	50 kw.	Excitation main units	Motor driven	Westinghouse Elec. & Mfg. Co.
1	Crane	Electric	35 tons	Engine room		Whiting Equipment Co.
1	Crane	Hand operated	10 tons	Engine room		Northern Engineering Works

should improve about 12 per cent. On this assumption, the 6000-, 3000- and 1500-kw. turbines at full load, 28-in. vacuum and 90 per cent. power factor, would require 14.7, 17 and 18.8 lb. per kw.-hr., respectively.

CONDENSER SURFACE AND STEAM CONDENSED

Kw. Rating, Turbine	Condenser Surface, Sq.Ft.	Surface per Kw., Sq.Ft.	Steam Rate, Lb. per Kw.-Hr.	Total Steam, Lb. per Hr.	Steam Condensed per Sq.Ft. of Surface, Lb.
10,000	19,000	1.9	13.7	137,000	7.2
6,000	18,800	3.13	14.7	88,200	4.7
3,000	10,000	3.33	17	51,000	5.1
1,500	4,000	2.66	18.8	28,200	7.05

It should be taken into account that the 6000- 3000- and 1500-kw. turbines have reciprocating dry-air pumps and that the surface of the condensers was based on a heat transfer of 350 B.t.u. The large unit employs a rotary wet-air pump and the condenser was based on a heat transfer of 500 B.t.u.; in fact, the latter figure is now standard for most of the large condenser companies. If the last three condensers in the table had been based on the higher heat transfer, the total surface in each case would be reduced to seven-tenths of the figure given and the steam condensed per square foot raised in proportion. The condenser for the 1500-kw. unit was designed to give a vacuum of 28 in., when the turbine was running at two-thirds load, so that 5.4 rather than 7.05 would be a representative figure. This was common practice at the time it was put in service. On the other hand, it would be possible to get 13,750 kw. from the large turbine and still maintain a vacuum of 28 in. with 65 deg. cooling water. At this load, the steam consumption would be 208,000 lb. and the condensation per square foot of surface nearly 11 lb.

For the recent installations and changes that have been made, W. S. Swarting was engineer in charge of construction, E. L. Cameron is chief engineer of the plant, and F. W. Reimers, general manager of the company.

Wasteful Ignorance

By Frank W. Hudson

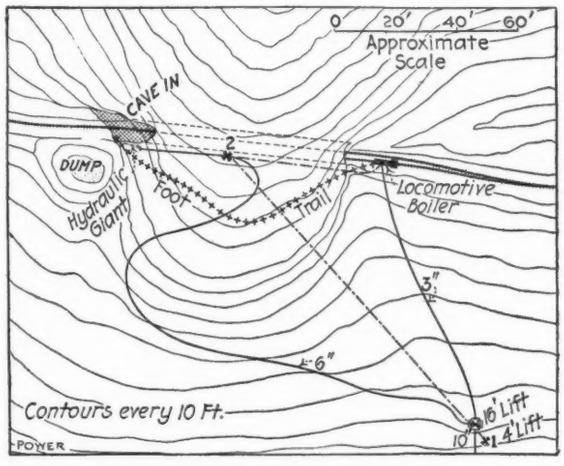
The man who believes in learning his trade solely by experience is ofttimes with his hands in empty pockets. While technical education is not the alpha and omega of mechanical success, it is undoubtedly the foundation upon which we must build.

Several years ago a railroad in the West suffered the loss of twelve days' crippled passenger and freight transportation service by the roof of a tunnel falling in, caused by a piledriver tower that was not lowered enough to clear. All the available men of the system, numbering about 1000, were dispatched to the scene.

With them came a steamfitter and pump man. He was a husky, broad-shouldered fellow who ridiculed the idea of a "book education," stating that he had "learned his trade right by practical experience" and informing one of his men that he did not want him to tell him anything. He was no doubt good at erecting small pumps for emptying oil cars or filling water tanks, but in this case it meant installing a giant to wash the earth down into sluice boxes and out on the dump as an auxiliary to the steam shovel employed in clearing the tunnel. This was unsuccessful because of the steamfitter's ignorance of the influence of the altitude, the best location for the pumps and the right manner of connecting them.

The pumps were of the commonly used duplex type, one having a 10-in. suction and 8-in. discharge, the other an 8-in. suction and 6-in. discharge. The point of delivery was about one hundred and fifty feet elevation and probably 600 ft. between the intake and discharge. A locomotive was sidetracked 400 ft. from the pumps to supply the steam. The altitude was 3000 ft. above the sea level. The illustration shows that the conditions were ideal, and this installation should have been completed by sundown. But what a delay a lack of a little knowledge can sometimes create! Eleven days later the tunnel had been cleared but without the use of the pumps.

The first thing done was to move both pumps near the river and connect both suctions to the 10-in. pipe that the large pump required and down into the river 16 ft. below. The discharges were then bushed down and connected into a 6-in. delivery pipe. Instead of running straight for a possible 600 ft. to the giant, an S-bend was run up the hill, using nearly a thousand feet of



Conditions Near Cave-In

pipe. When the pumps failed to deliver water he said: "She's got me buffaloed. There's no reason why she won't work." It didn't, however, and he finally let the pumps down to within 6 ft. of the water; then he only got small results.

With an ounce of sense, he would have placed the large pump at the cross marked "1" within four feet of the river, and the smaller one at "2." Then he should have laid the pipe between the two, as indicated by the dotted lines. However, this much more experience was added to his education.

Proportionate Wages—Paying $125 to $150 a month to a fire-room foreman who has the handling of thousands of dollars worth of coal, may seem excessive to some managers, but in several progressive stations rates as high as 45 cents per hour are paid firemen so as to attract efficient men.

Anthracite Coal Production in 1913—The production of anthracite again broke the record in 1913, exceeding the highest previous output by nearly 1,000,000 tons, according to figures compiled by E. W. Parker, coal statistician of the United States Geological Survey. Including the coal recovered from old culm banks and a small quantity dredged from the Susquehanna River, the production for the year was 81,718,680 long tons, valued at $195,181,127, compared with 75,322,855 tons, valued at $177,622,626 for 1912. This is an increase of over 6,000,000 tons in quantity and more than $17,500,000 in value. The previous highest record was 80,771,488 long tons, in 1910.

Poor Brine Circulation Cause of Decreased Output in Ice Plants

By Peter Neff

The brine circulation about the cans in an ice tank is one of the governing factors in ice production, and, while a considerable amount of thought has been given to this subject, it is surprising to find how often conditions exist which indicate that the arrangement used had not been sufficiently thought out to meet these conditions.

Propellers are now quite universally used for producing the circulation of the brine, and when properly applied are both economical and effective.

Where coils are used in the ice tank there is less liability for improper circulation than where shell-type brine coolers are employed. In this article we will confine ourselves to a class of troubles which are more apparent where the brine cooler is used, and yet the principles involved are applicable to any propeller circulation.

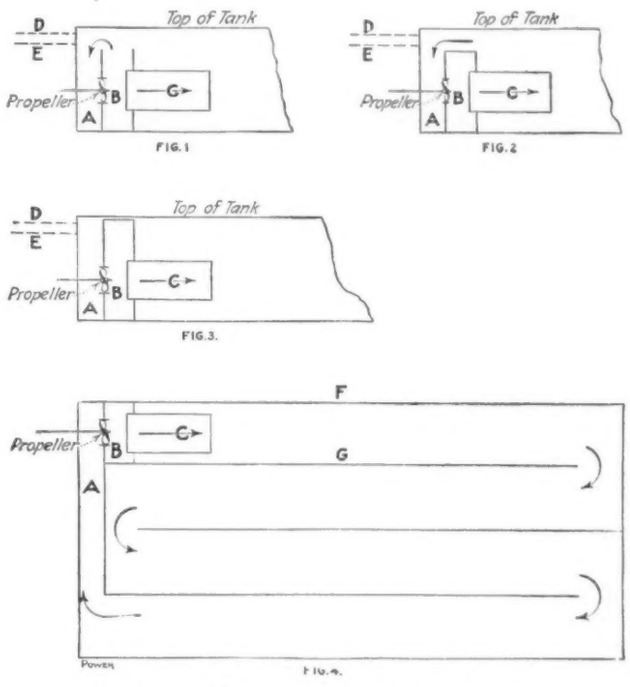
Rapidity of circulation being the great desire of all has led manufacturers to increase the size of the propellers as well as the speed at which they operate in order to accomplish this end. The shell-type brine cooler of a necessity restricts the flow of the brine and makes it imperative that the brine be forced through the tubes. These brine coolers are variously installed, but the sketches herewith show the usual arrangement in its main features. In all cases *A* being the space for the passage of the brine to the propeller; *B*, the space into which the propeller discharges the brine; *C*, the cooler itself, while *D* and *E* represent the two brine levels on either side of the propeller and form the head for the flow of the brine. This head in some instances is six inches.

As stated, the brine cooler offers some resistance to the passage of the brine, and there is the added resistance to the flow due to the passage about the cans. In describing the following troubles, it must be understood that they are not based on theoretical assumptions, but are to be found in actual practice.

Assume a system installed as shown in Fig. 1. It is desired to keep the brine level in the tank between *D* and *E*. It should be remembered that it is desirable to keep the brine level well up on the cans, for when this is not the case it is difficult to freeze the cakes solid. In the case of Fig. 1 there will be scarcely any circulation of brine about the cans, as it will simply take the path of least resistance and return to the propeller by flowing over the partition in which the propeller is located, as indicated by the arrow. This construction will work only when the level *D* is kept below the top of the partition in which the propeller is placed. In order that the brine may be kept as high as possible about the cans, the propeller is slowed down until the difference in levels *D* and *E* is small; this will help the circulation in the tank, but usually it will be so weak as to be practically valueless. In such cases as this the owners state that they get better circulation by running the propeller more slowly, which, when one first hears it, seems paradoxical; but it is true.

It is but natural to think of putting a top on the space *B* and keep the brine in, but when this is done you may have the trouble as indicated in the sketch, Fig. 2. Here *B* is closed and the brine forced through the cooler; but when it banks up to get head to overcome the resistance to its flow among the cans, it finds an easier flow back over the top of *B*, and the result as far as the tank circulation is concerned is no better than in the case of Fig. 1.

Fig. 3 shows the best way of guarding against this back-flow trouble where the space *B* is covered well above the level *D*. But even here one may have trouble unless



Showing How the Brine Circulates

the box *B* is carried full height tightly between the circulating partitions *F* and *G*, as shown in Fig. 4.

In this, as in so many of the appliances used in the process of mechanical refrigeration, it would appear that the users had not given the matter the careful consideration it deserved, but had been content with the old cut-and-try plan so evident in the early days of the industry. What is wanted now in every part that goes to make up the whole equipment is economical effectiveness.

A study of propellers as to diameter, speed, pitch, number and form of blades, etc., consideration of the circulation in the tank, how long the tank should be and of what cross-section, uniformity of flow in all parts of the tank—all would not only be interesting but productive of economical results. Such practices as herein outlined should not be allowed to continue, for brine in any ice tank should not be allowed to short-circuit.

The Double-Arch Bridge-Wall Furnace*

By Osborn Monnett†

SYNOPSIS—Arrangement and areas of furnace with a table giving the necessary dimensions for all commercial sizes of horizontal return-tubular boilers.

All of the necessary requirements for good combustion the No. 4 furnace supplied, but there were disadvantages about the construction. The boiler had to be set high; the single-span arch necessitated additional buck stays in the setting, and the construction was not such as could

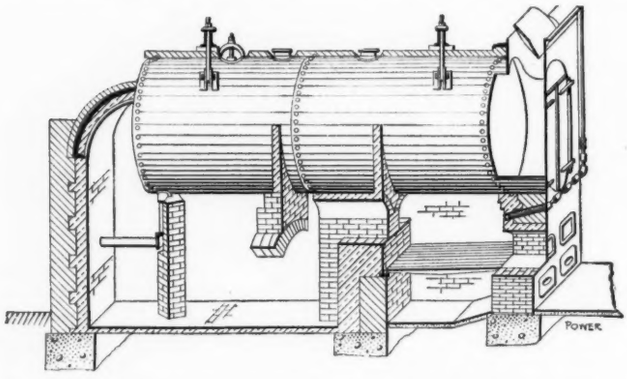


Fig. 1. Double-Arch Bridge-Wall Setting for a Two-Course Boiler

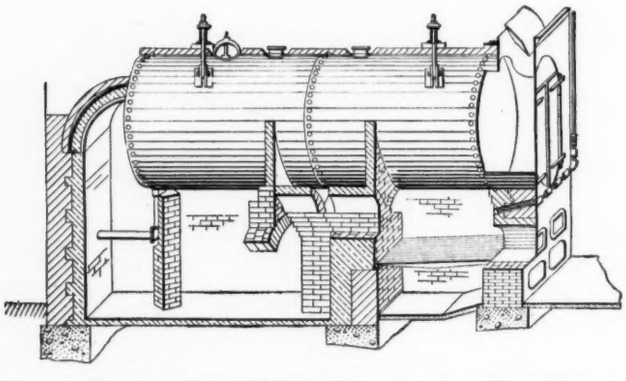


Fig. 2. Double-Arch Bridge-Wall for a Two-Course Boiler

be expected to stand high temperature under heavy service. Consequently a construction which would be better adapted to the conditions was sought. Finally, a modification of the old Gulickson setting was worked out and is known as the double-arch bridge-wall furnace. Credit for this development is not claimed by the Department of Smoke Inspection; it should be given to the various contractors who installed similar settings. This development was more of an evolution representing the combined efforts of all of those engaged in the study of smoke suppression than to the efforts of any one individual.

The furnace, adapted to two-course and three-course boilers, with seams open for inspection as provided in the regulations of the Chicago Boiler Inspection Department, is shown in Figs. 1, 2 and 3. It provides an uncovered grate with siphon steam jets and panel doors through which sufficient air may be admitted over the fire, a double-arch, brick-wall construction over and back of the bridge-wall for a distance of about 4 ft., and a single-span deflection arch. With a good draft, and if carefully handled, this furnace can be run without producing dense smoke. The panels should have a free opening of 4 sq.in. for each square foot of grate surface, and should be freely used after firing, together with the steam jets.

Assuming that the average steam jet when in operation uses 10 per cent. of the total steam generated, that the fire is charged six times per hour and that the steam jets are used for 2 min. after each firing, it will be seen that the total time of steam-jet operation will be 12 min., or one-fifth of an hour. The steam used by the jets will therefore be one-fifth of 10 per cent., or 2 per cent. of

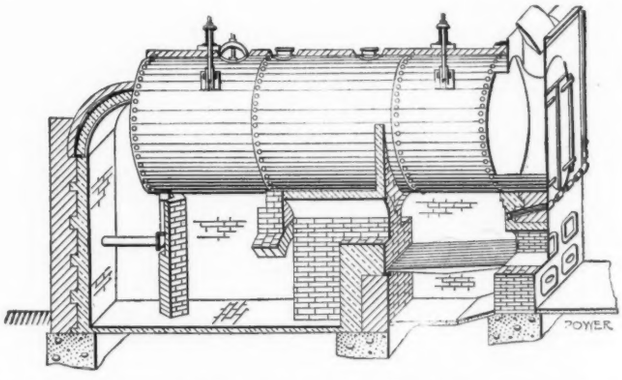


Fig. 3. Double-Arch Bridge-Wall Setting for a Three-Course Boiler

the total steam generated, which cannot be considered excessive if smokeless results are a consideration.

Air Admission

Many experiments have been made as to the best location for the admission of air over the fire. Some of the most common places are: Back of the bridge-wall, through the top in the front face, through the sides immediately in front, along the side walls of the furnace, over the front of the fire-doors, etc. From these experiments it has been found that the most effective location for air admission is at the dead plate. This can be explained when it is considered that the purpose of admitting air is to bring it into contact with the volatile matter. Air admitted at the dead plate naturally takes a course immediately across the fire, owing to the action of the draft, producing a scrubbing action as it were, and bringing the oxygen into intimate contact with the volatile matter coming off from the fuel. At the same time the air is being heated preparatory to entering the high-temperature zone where it is more thoroughly mixed with the hot gases, producing a secondary combustion as the gases pass under the deflection arch. This secondary combus-

*Copyright, 1914, Osborn Monnett.

†Smoke Inspector, city of Chicago.

tion can be seen when looking through the rear clean-out door of such a setting.

Areas through Furnace

Back of the bridge-wall the setting consists of a two-span or butterfly arch. This construction stands up under the heat better than a single span, and also imposes a minimum stress on the side walls, thereby obviating the use of buck stays. One of the essentials of this setting is that proper areas be provided through the furnace. There must be a free opening of at least 25 per cent. of the grate surface at the double-arch bridge-wall; the space between the back of the bridge-wall and the deflection arch must show an area of at least 45 per cent. of the grate surface, while the area under the deflection arch should be at least 50 per cent. of the grate surface. To get this area under the deflection arch, it will frequently be found necessary to excavate in the combustion chamber, but this should be done rather than interpose a restriction at this point.

One of the fundamental principles of the setting requires that the top of the span of the deflection arch should be on a level or below the top of the bridge-wall; never above. This insures positive deflection and mixture. The combustion chamber should be paved with second-grade firebrick on edge, as the peculiarities of the furnace concentrate considerable heat on the bottom of the combustion chamber.

Fig. 4 and the accompanying table give the necessary dimensions for all commercial sizes of horizontal return-tubular boiler set with double-arch bridge-wall furnaces.

DIMENSION SHEET FOR FIG. 4

(All Dimensions in Inches except Column B which is in Feet)

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
42	12	28	19	42	42	22	16	42½	3½	16½	18	21	9	16½	9	15	+27½	15	9	8	13½	8
42	14	28	19	48	42	22	16	44	4	15	18	24	9	16½	11	17	27	17	9	8	13½	8
48	12	30	20	42	48	24	18	45½	3½	18	18	20	9	19½	7½	15½	+30	15½	9	8	13½	8
48	14	30	20	48	48	24	18	45½	4	16½	18	24	9	19½	9½	17½	+28	17½	9	8	13½	8
48	16	30	20	54	48	24	18	49½	4½	15	18	26	9	19½	11½	19½	30	19½	9	8	13½	8
54	14	32	22	48	54	24	18	49½	4	16½	18	24	13½	20½	11½	18	+30	19½	9	9	13½	8
54	16	32	22	54	54	24	18	51½	4½	15½	18	24	13½	20½	13½	20	30	21½	9	9	13½	8
60	16	34	22	60	60	26	18	55½	5	17	22½	26	13½	23½	13	22½	33½	22	9	10	13½	8
60	18	34	22	66	60	26	18	60½	5½	15½	22½	26	13½	23½	15	24½	36½	24	9	10	13½	8
66	16	34	24	60	66	28	18	54½	5	18½	22½	28	13½	26½	11½	22½	34	20½	9	11	13½	8
66	18	34	24	66	66	28	18	59	5½	17	22½	28	13½	26½	13½	24½	36½	22½	9	11	13½	8
72	16	36	24	66	72	30	20	59½	5½	18½	22½	30	13½	29½	11½	24½	37	22½	9	12	13½	8
72	18	36	24	72	72	30	20	64½	6	17½	22½	30	13½	29½	13½	26½	40	24½	9	12	13½	8
78	18	38	26	72	78	32	21	65	6	19	26	32	18	30	15½	27½	40	25	9	12	13½	8
78	20	38	26	78	78	32	21	70	6½	17½	26	32	18	30	17½	29½	43	27	9	12	13½	8
84	18	38	26	72	84	32	21	64	6	20	26	36	18	33	14	27½	40	24	9	12	13½	8
84	20	38	26	78	84	32	21	69	6½	18½	26	36	18	33	16	29½	43	26	9	12	13½	8

Notes:—First grade of fire brick to be used throughout with the exception of the combustion chamber floor and the side walls of the chamber back from a point one foot behind the rear face of the deflection-arch.
Fire doors must provide for special air admission of an area equal to 4 sq.in. for each square foot of grate surface.
Make damper openings equal to 25 per cent. excess of tube area.
Dimensions in the above table apply only for the ordinary conditions and are subject to revision for unusual conditions.

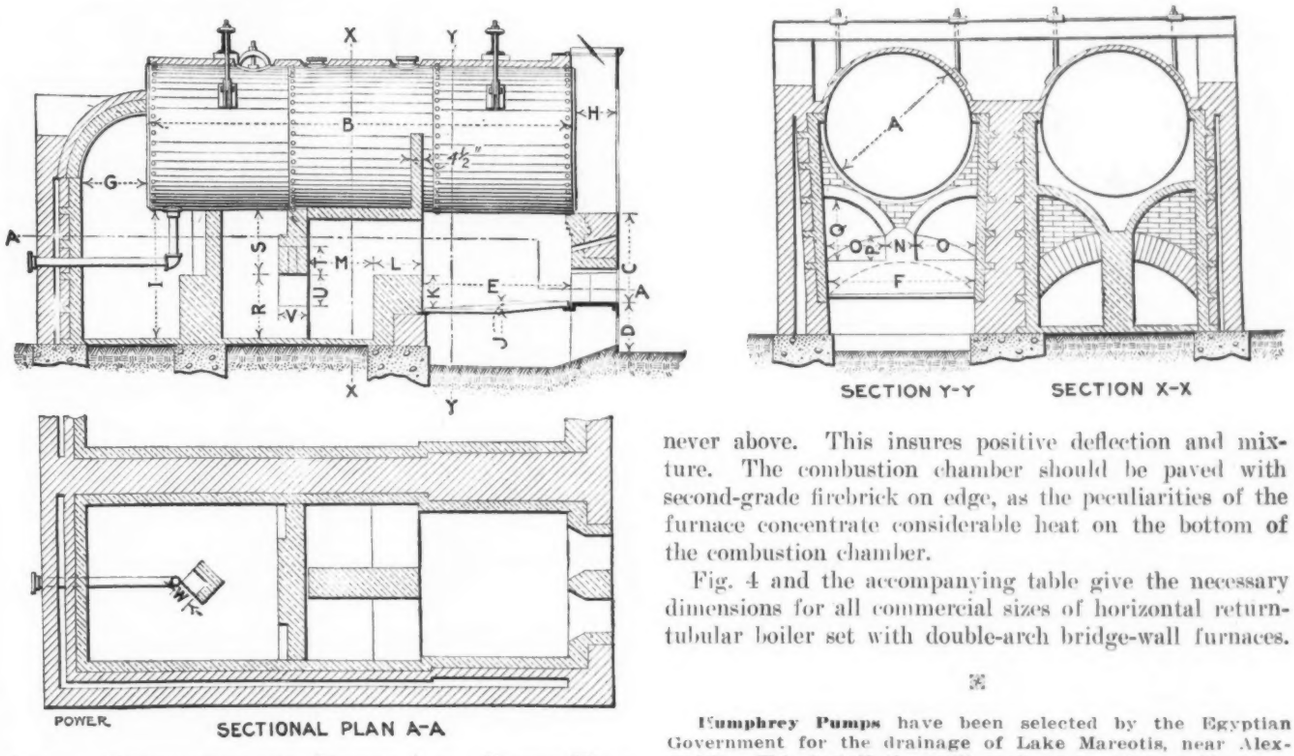


Fig. 4. Dimensions for Double-Arch Bridge-Wall Furnace for All Commercial Sizes of Boilers

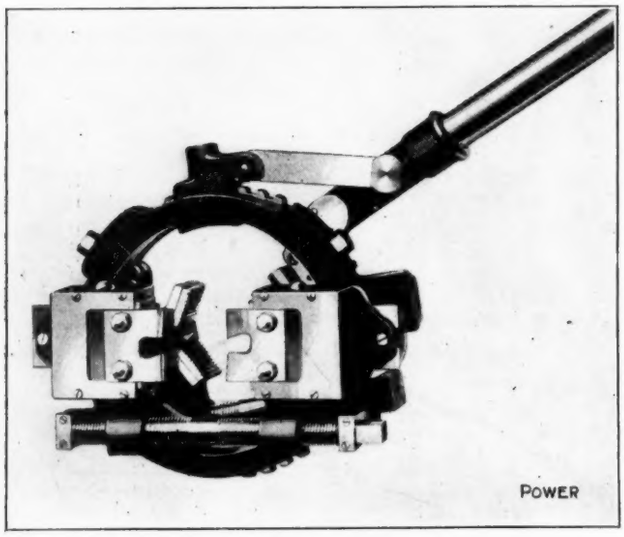
Humphrey Pumps have been selected by the Egyptian Government for the drainage of Lake Mareotis, near Alexandria. This installation will rank among the world's largest pumping stations, the complete equipment consisting of eighteen pumps each having a capacity of 100 million gallons per day through a lift of 20 feet. Each pump will be about two and one-half times the size of those installed last year at Chingford, England (See "Power", April 29, 1913), and will have an internal diameter of nearly nine feet. Gas will be furnished by nine specially designed anthracite producers. In addition, there will be installed a gas-engine lighting and power plant. Only ten of the Humphrey pumps will be installed immediately.

Duty to Contractor's Employees—An electric power company is liable for injury to a contractor's employee while at work on the company's premises, due to negligent failure to warn him against the danger of coming in contact with an uninsulated high-voltage wire, if the danger is not obvious to him, according to a recent decision of the Idaho Supreme Court announced in the case of Gagnon vs. St. Maries Light & Power Co., 141 "Pacific Reporter," 88.

Beaver Square-End Pipe Cutter

This tool cuts off pipe with a square end, without leaving any burr. The cutting knives have automatic feed.

The cut is regulated so that a very thin section of the pipe is cut out, similar to a cutting-off tool in a lathe,



SQUARE-END PIPE CUTTER

instead of depressing it, leaving the pipe clean and square. The pipe cutter, manufactured by the Borden Co., Warren, Ohio, illustrated herewith, does not split the pipe and leaves the full area.

Hammond Water Meter

Every modern power station is equipped with some kind of a water meter, so that accurate and continuous records can be kept of the amount of water used in the various apparatus. Generally, the water to be metered is at a high temperature, and to meet this condition the meter illustrated herewith has been designed and placed on the market by the Alberger Pump & Condenser Co., 140 Cedar St., New York City. As shown in Figs. 1 and 2, the machine is simple in construction and its operation is easily understood. All its parts are on the outside, making it easy of inspection, and small, delicate parts have been eliminated. The meter has no valves, it is not affected by oil or mud in the water, and it will measure liquids at any temperature.

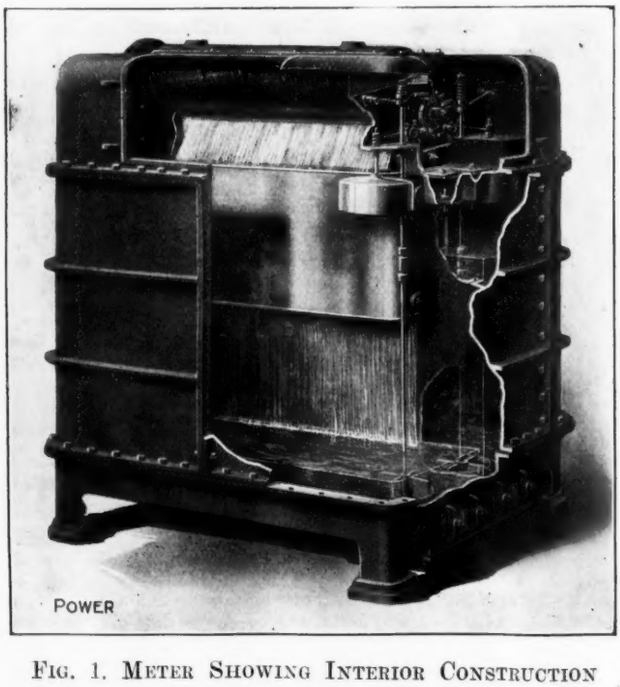


FIG. 1. METER SHOWING INTERIOR CONSTRUCTION

The shell is constructed of cast-iron sections, bolted together. The meter consists of two tanks, an upper receiving tank *A*, Fig. 2, in the top part of the meter, and a lower measuring tank *B*, divided into two compartments by a central vertical partition *C*.

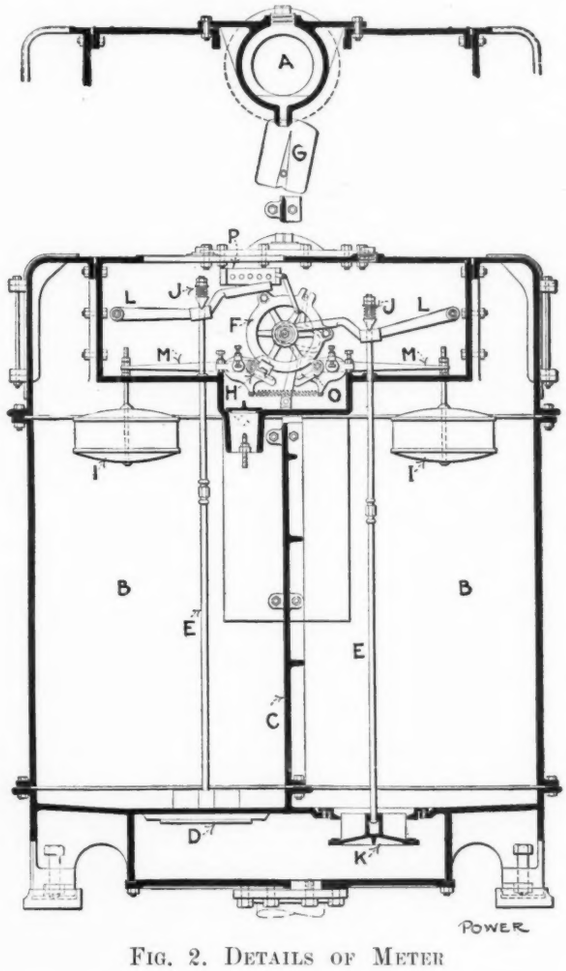


FIG. 2. DETAILS OF METER

Liquid enters the receiving tank and flows through a slot in the bottom into the measuring tank *B*, which has a discharge valve *D* and *K* opening downward, one in each compartment. The valves are held to their seats by the valve rods *E* and are operated by the lever arms *L*. The tilting inlet valve *G* is moved by a wristplate, thereby deflecting the water either into the right or the left compartment. With the tilting valve *G* and the wristplate *F* in the positions shown, the water flowing into the left measuring tank, the operation is as follows:

The discharge valve *D* is kept to its seat by the wristplate *F*, which is held by the latch *H*. As the water rises in the compartment, it lifts the float *I*, which, through the lever *M*, unhooks the latch *H* and releases the wristplate. The weight of the water on the discharge valve *D* instantly pulls down the valve and rotates the wristplate.

This turns the tilting inlet valve *G* to deflect the water into the right measuring tank *B;* at the same time it draws up the discharge valve *K* to its seat, where it is held by the latch *O,* ready for the water now flowing into the right compartment. The springs *J* on the head of the valve rods *E* hold the discharge valves up to their seats and keep them tight.

The hardened-steel wristplate and latches have hook blocks similar to those on the valve gear of a Corliss engine. The wristplate is mounted on ball bearings, as are the rollers on the rim of the wristplate on which the levers controlling the valves roll.

The operation of the meter is automatic and continuous, and a record of the cycles of operation is registered on a revolving counter *P.*

The movement of the valve mechanism when the meter trips is instantaneous. A gage with a metal point is fitted on each compartment of the measuring tank with the point so set that the compartment will contain the required amount of liquid for which the machine is calibrated. The working parts are then so adjusted that at the instant the liquid closes over this point, the mechanism trips and the contents of the compartment are discharged.

The meter is guaranteed to operate within one per cent. of absolute accuracy, at any rate of flow up to its capacity, and at the temperature for which it was calibrated. It is made for capacities of 25,000 lb. of water per hour up to 300,000. The smallest size of inlet is 3 and the largest 10 inches.

Providence Centrifugal Pump

Centrifugal pumps in two styles—the double suction for generating moderate heads and the multistage for greater heads—are built by the Providence Engineering Works, Providence, R. I.

Their characteristics of design are accessibility to all wearing parts without disturbing the pipe connections, without disturbing any pipe connection when inspecting the pump interior. The lower casing has flange openings below the shaft for the suction- and discharge-pipe connections. This arrangement makes it easy to connect the pump and the pipes are out of the way. Fig. 2 is an exterior view of the multistage pump connected to a motor.

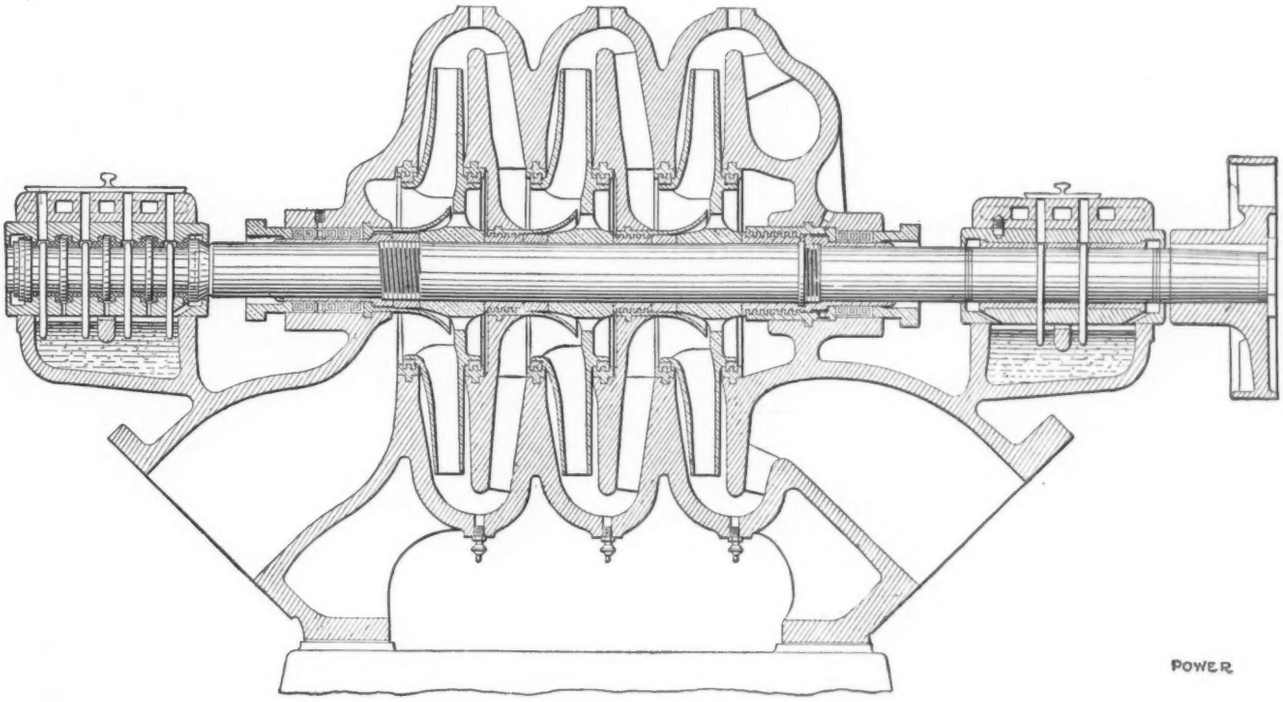


FIG. 1. SECTION THROUGH MULTISTAGE PUMP

simplicity of construction and operation, easy connections to the suction and pressure mains, and a properly designed passage throughout the pump and impeller to insure an undisturbed flow of fluid. All the parts subject to wear are easily removed and renewed; they may be furnished by the manufacturer or made by the user of the pump if it is more convenient.

The pump casing is split on a plane passing through the shaft axis, so that the upper casing may be removed The design of the pump is so simple that it can be stopped, opened, inspected, closed and made ready to start in less than 45 minutes.

The suction duct is so disposed as to lead the incoming current smoothly and at a uniform rate through the inlet flange and bring it in a compact mass up to the inner edges of the impeller vanes. As the liquid is protected from the rotating effect of the impeller hub, it enters undisturbed in a radial direction into the rotating-vane pas-

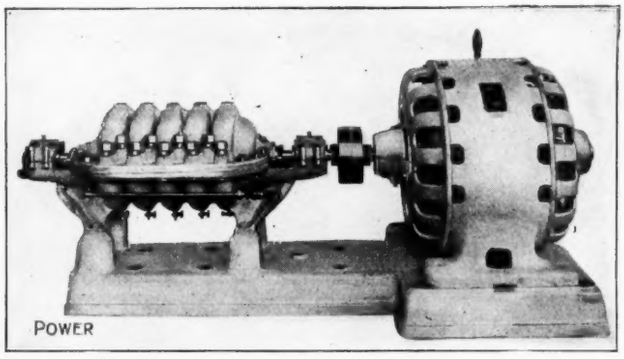


FIG. 2. MULTISTAGE CENTRIFUGAL PUMP, MOTOR DRIVEN

sages, where the vanes impart to it a gradually increasing degree of rotation, finally delivering it into the discharge chamber. This is one of the main features of the pump and much attention has been given to its design, so that the water must reach the impeller vanes in a compact and undisturbed state. This action will increase the pump capacity over what it would be if the liquid was disturbed by contact with the extensive surfaces of the impeller hub and web.

The method of protecting the incoming water from the action of the impeller hub is shown in Fig. 1, a sectional view of a multistage pump. The inlet duct terminates in a conical shell extending close to the impeller vane. This shell is of bronze, except where ammonia liquors are handled, in which case the apparatus is made of cast iron.

As shown in Fig. 1, the casing is shaped to make the travel from the periphery of the impeller through the discharge flange as direct as possible and it is proportioned to permit gradual and unhindered reduction of the jet velocity.

The two parts of the casing are bolted together with a manila paper gasket between. The gasket is shellacked to the lower casing and covered with graphite paste on the upper side, which readily allows removing the upper casing without destroying the gasket.

The impeller is of the inclosed type, in which the sides of the vanes are cast integrally. The vane passages are spaced to suit the working conditions imposed, and are hand finished; the outer sides of the hub of the impeller are machined. The impellers are made to suit the wear and corrosion according to the liquid to be handled; generally, they are made of gun metal. On each side and surrounding the inlet opening, the impeller is fitted to receive packing rings of the same material as the impeller. The impeller is keyed to the shaft and adjusted to permit its easy removal when necessary.

Leakage from the impeller chamber into the inlet chamber cannot be prevented, but it is checked by means of radial labyrinths between the inner walls of the impeller and the casing walls. This feature is shown in Fig. 1. In Fig. 3 are shown details of the radial-impeller labyrinths which are used exclusively in these pumps. They allow the slight eccentric movement of the rotating member without altering the efficiency of the joints. The lateral clearance is preserved through careful hydraulic balancing of the rotating parts and adjustment of the thrust bearings. What leakage takes place does not interfere with the incoming current and mingles with it a short distance before their common entrance into the impeller proper. The casing labyrinths are composed of rings made in halves and each is so fastened that when the pump cover is removed for inspection, the upper halves of the casing rings remain attached to the cover, thus allowing an unhindered view of the surfaces of the other parts; that is, the impeller ring which screws on each side of the impeller, as shown in Fig. 3.

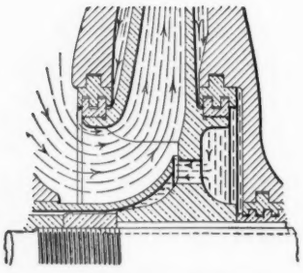


FIG. 3. RADIAL IMPELLER LABYRINTH

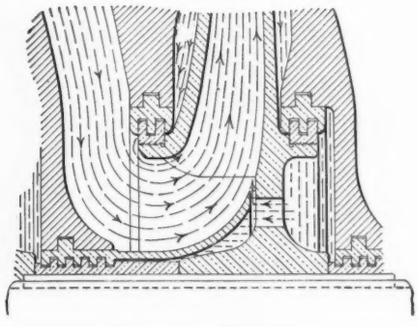


FIG. 4. DIAPHRAGM LABYRINTH

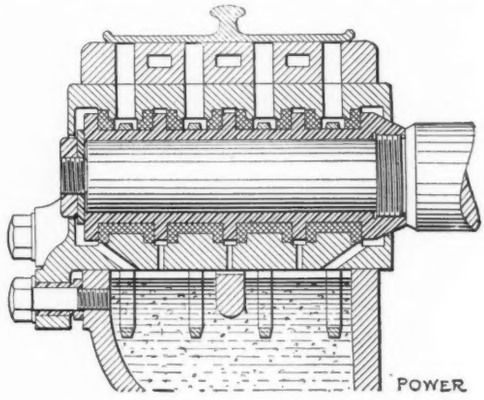


FIG. 5. THRUST BEARING

On either side, the impeller has labyrinth rings to prevent leakage from the discharge chamber into the impeller intake, but in the multistage pump two adjacent pieces are separated by a diaphragm having an opening through which the shaft passes. This is shown in Fig. 4.

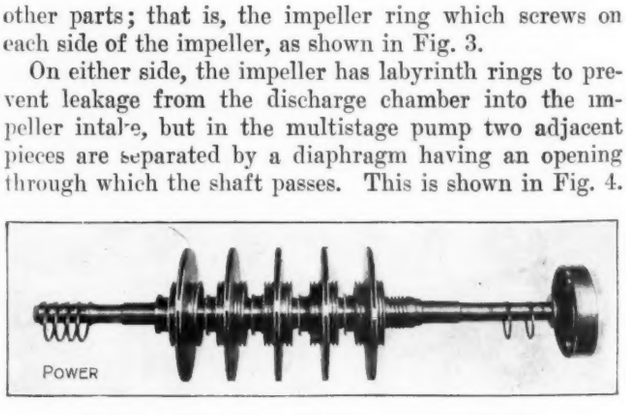


FIG. 6. ROTATING PARTS OF THE PUMP

The casing shell of the radial labyrinth is split so that the upper half (it is held in the pump cover in the same manner as the impeller-casing labyrinth) is attached when the cover is removed; all the parts subject to wear are accessible for examination. The casing shell extends into the inlet chamber of the next impeller and also serves as a guide wall, thus leading the incoming liquid into

the impeller passages and preventing the contact of the liquid with the rotating surfaces of the impeller web and hub. The axial clearance between the labyrinth flanges is the same as in the impeller labyrinth, while the radial clearance is sufficient to accommodate any ordinary eccentric motion of the shaft. The bronze casing, impeller and diaphragm labyrinths, for ordinary conditions, are composed of 88 parts copper, 10 parts tin and 2 parts zinc.

The bearings are in brackets cast integral with the lower part of the pump casing, one being plain and the other a combination of plain and marine thrust bearings. The plain bearing is a split cast-iron shell lined with babbitt and arranged for ring oil lubrication; it is located usually near the driving end and the other is then outboard. The bearing shell can be rebabbitted by any mechanic. The outboard, or combination bearing, known as a thrust bearing, Fig. 5, is a split, cast-iron shell, grooved and babbitted to accommodate a removable and renewable steel thrust sleeve carried by the shaft. This sleeve has thrust collars which fit babbitted grooves in the shell. Between any two adjacent collars, there is an oil ring which lubricates the plain parts of the sleeve as well as the sides of the two collars.

One end of the shell is provided with a bolt and thimble attachment whereby close adjustment of the bearing as to the thrust collar can be had and maintained. Both bearings are readily accessible for inspection by simply removing the caps and lifting the upper shells which expose the wearing surfaces of the shaft. The design of the shell is such that the upper one can be easily removed and then the lower ones may be turned around the shaft and also removed without trouble. The caps are cored out so that, in case hot liquids are handled, they can be connected to a cold-water system and the bearings thus cooled through contact of the upper bearing with the inner surface of the cap.

The shaft is protected from contact with the liquid passing through the pump by the impeller hub and locking nut. The rest of the shaft, on both sides of the impeller and that which passes through the stuffing-boxes, is protected by sleeves screwed to the shaft itself and extending past the packing. These sleeves are removable and renewable, and of material which will withstand the action of the various liquids handled. The rotating parts of the pump, Fig. 6, are balanced, first on parallels and eventually by speed trials without handling water. With the double-suction pump, both sides of the impeller are symmetrically disposed, thus an equal amount of water may traverse each side of the impeller from the suction chamber to the discharge chamber.

The hydraulic balancing of the multistage pump is obtained (a) by symmetrically disposing the impeller labyrinths on each side of each impeller; (b) by providing communication from the balancing chamber formed on the rear of each impeller through the web and into the impeller inlet proper, so as to cause the pressure to be practically the same at these two points and that the liquid traversing from one to the other does not disturb the flow of liquid entering the impeller passages; and (c) by having on the high-pressure side of the pump a labyrinth pressure-reducing device. This materially assists the operation of the packing in the stuffing-box, because the soft packing is practically under the same pressure as at the suction end. This labyrinthine device leads into a small chamber which communicates with a suction duct through a small pipe having a regulating valve. A slight adjustment of this valve suffices to counteract any imperfections in the ordinary balancing of the pump which might develop during irregular operation.

Referring to Fig. 7, it will be seen that the pump bedplate is of very light construction since ordinarily it is to be grouted onto solid foundations, the manufacturers believing that in many places the first cost may be reduced appreciably by omitting the cast-iron base and

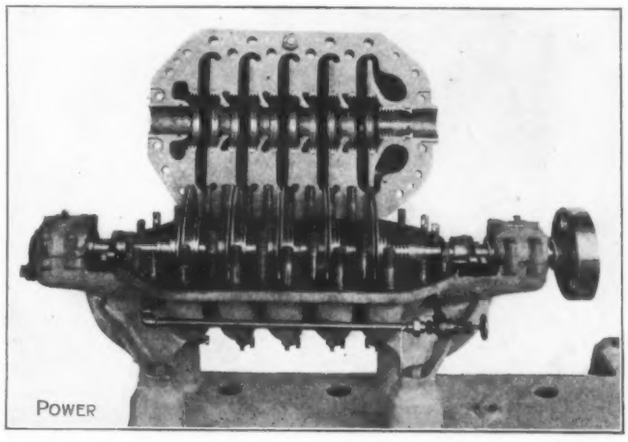


FIG. 7. MULTISTAGE PUMP WITH COVER LIFTED

mounting the pump and its motor directly upon a concrete foundation as, except when engine driven, heavy and expensive foundations are not required. Besides, experience has shown that, no matter how heavy the bedplate may be, whenever the pump or its prime mover gets out of alignment, due mostly to stress in the piping, the bedplate is never ungrouted, but, instead, the pump is shimmed up or suitably shifted until the alignment is again obtained. This points to a possible reduction in first cost through the omission of a bedplate whenever feasible.

Reducing Barometric Readings to Standard Pressures

BY D. O. BARRETT

The accompanying table gives the pressure in pounds per square inch, also in pounds per square foot for various barometric readings from 28.5 to 30.64 in. This table is calculated, using as the density of mercury 846.8 lb. per cubic foot, the value given by Kent at a temperature of 60 deg. F.

Barometric Pressure	Lb. per Sq.In.	Lb. per Sq.Ft.
28.50	13.966	2011.2
28.60	14.015	2018.2
28.70	14.064	2025.3
28.80	14.113	2032.3
28.90	14.162	2039.4
29.00	14.211	2046.4
29.10	14.260	2053.5
29.20	14.309	2060.5
29.30	14.358	2067.6
29.40	14.407	2074.6
29.50	14.456	2081.7
29.60	14.505	2088.7
29.70	14.554	2095.8
29.80	14.603	2102.9
29.90	14.652	2110.0
30.00	14.701	2117.0
30.10	14.750	2124.1
30.20	14.799	2131.1
30.30	14.848	2138.2
30.40	14.897	2145.2
30.50	14.946	2152.3
30.60	14.995	2159.3
30.62	15.005	2160.7

Density of mercury, 846.8 lb. per cu.ft.

Gas-Engine Plant for Bottle Works

In general design and construction, the new power plant of the Owens-Eastern Bottle Co., Clarksburg, W. Va., represents the latest practice in gas engineering. The fuel, natural gas, passes through the low-pressure regulator at 8 oz. and is further reduced to approximately atmospheric pressure in a special gasometer, which is between the throttle and the engine.

Each of the two main units consists of a horizontal, single-tandem, double-acting C. & G. Cooper engine directly connected to a Crocker-Wheeler direct-current generator. The cylinders are 24 in. in diameter by 36-in. stroke, and when running at 125 r.p.m., each engine develops 600 hp. A fairly constant load is carried over a continuous 24-hr. service, each unit operating alternately for two-week periods. A third unit will be installed later.

Fig. 1 is a general view of the engine room and Fig. 2 shows the piping side of one of the engines while in the erecting shop. The main layshaft carries the eccentrics operating the inlet and exhaust valves, and through a set of helical gears it also drives the small ignition layshaft, from which the igniters and special multiple force-feed cylinder lubricators are mechanically operated. The upper helical gear can be shifted longitudinally on the

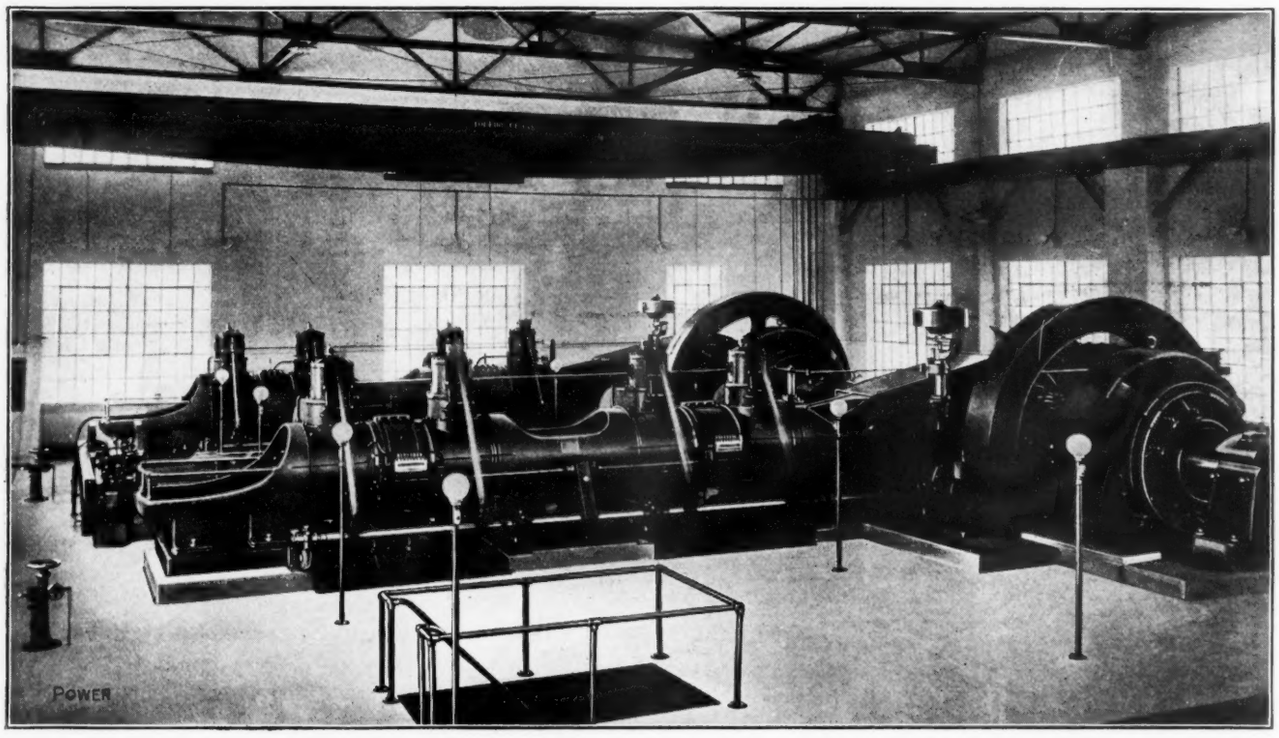


FIG. 1. ENGINE ROOM, SHOWING TWO UNITS NOW INSTALLED

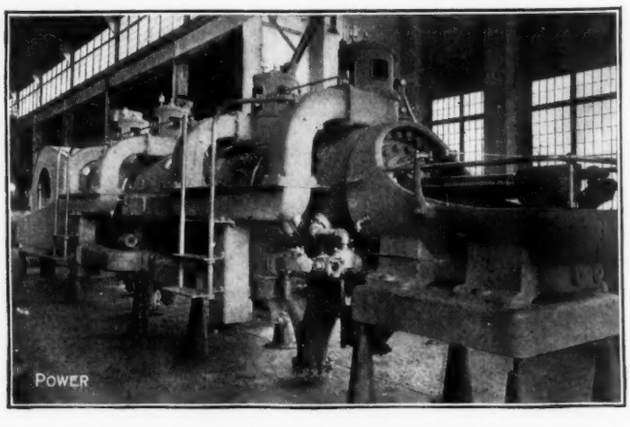


FIG. 2. SHOWING PIPING SIDE OF ENGINE

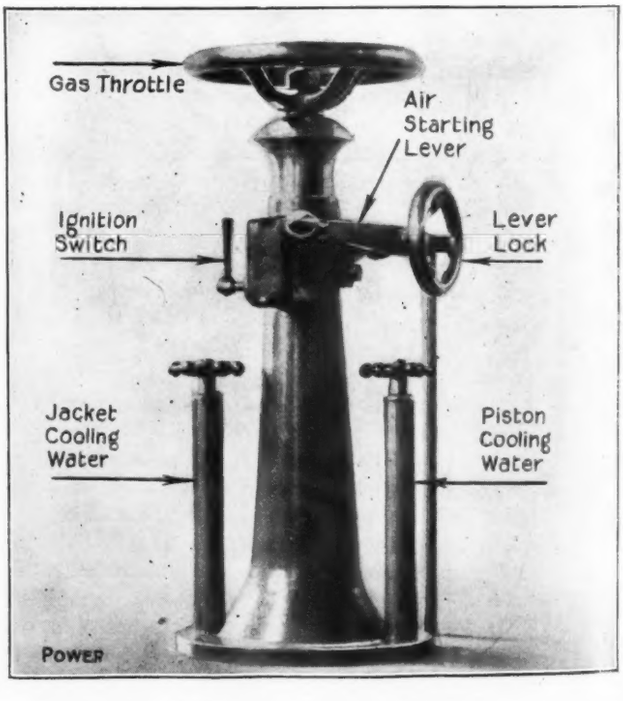


FIG. 3. OPERATING STAND

shaft and locked by means of a hand lever on the side of the gear case, thereby uniformly advancing or retarding all the ignition trips while the engine is running. The gas and air piping (Fig. 2), is arranged to form a stairway and platform, so that the operator may conveniently oil and inspect the inlet gear.

The simplicity of starting and stopping is also a feature, the floor-stand throttle valve or operating center being shown in Fig. 3. The gas, air starting, and water valves, as well as the ignition switch, are all on this stand. To start the engine, the compressed-air valve must first be opened, then the gas valve, and as soon as ignition takes place in the cylinders, this pressure air is replaced by the regular explosive mixture. The air-starting device is automatically thrown out of service when the air valve at the throttle is closed. Force-feed lubrication is supplied automatically to all main moving parts when the engine is started. An automatic safety stop is provided on each engine, which trips a switch in the ignition circuit should the engine speed exceed 10 per cent. above normal.

The gas consumption is about 10 cu.ft. per horsepower-hour, and the plant complete, including the building, main units, foundations and auxiliaries, will cost approximately $90 per kilowatt.

Connections for Gravity Returns for Heating Boilers

By J. E. Terman

SYNOPSIS—Where two or more boilers are connected in a gravity-return, steam-heating apparatus, the method of best arranging the return connections and placing the boiler check valves is often open to discussion. The author outlines three methods, giving the objections to the first two and reasons why the last is to be preferred.

According to the Massachusetts rules, "the main return pipe to a heating boiler (gravity-return system) shall have a check valve and also a stop valve between the check valve and the boiler," and "when there are two connected boilers (gravity-return systems), one (1) check valve may

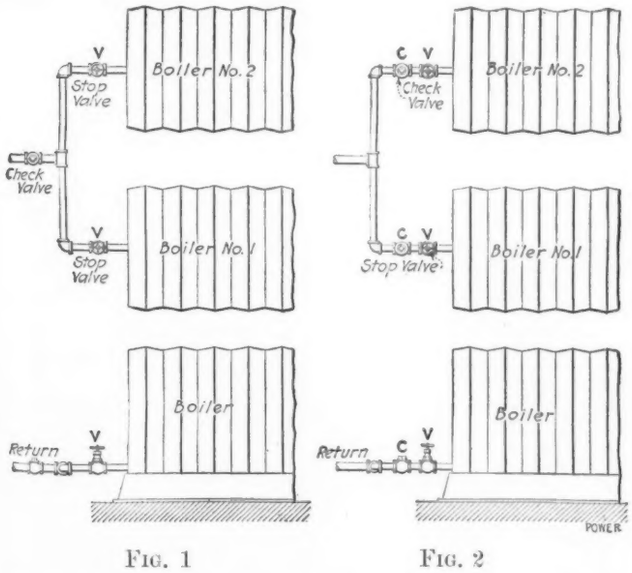


Fig. 1 Fig. 2

Plan and Side Views of Check-Valve Connections for Returns of Connected Gravity-Return Boilers

be placed on the main return pipe and a stop valve on the branch pipe to each boiler," as shown in Fig. 1.

With the arrangement shown in Fig. 1, in shutting down one of the boilers, if its steam stop valve is closed while a fire is still under the boiler, and the attendant neglects to close the return stop valve *V*, the continued generation of steam would build up a pressure by which the water of the boiler would be forced into the other boiler, causing the cutout boiler to be burned or cracked, if not more seriously damaged.

For meeting such conditions, the suggestion is often made that a separate check valve could be placed on each boiler, as shown at *C* and *C* in Fig. 2, but, comparing the relative safety of the two methods, there is a number of

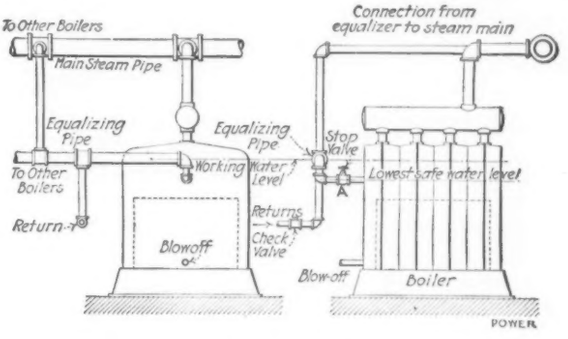


Fig. 3. End and Side View of Gravity-Return Connection Made above Water Line of Boiler

important considerations. The chances that circumstances may cause an accident with the arrangement shown in Fig. 1 are slight, for an attendant who would close the steam stop valve on the boiler which was to be cut out of use would probably also close the return stop valve.

The objection to having a separate check valve on each boiler, as shown in Fig. 2, is the impossibility of maintaining the proper water level. With any arrangement of return connections it is difficult to secure the same frictional resistance in pipes and fittings, and with the boilers connected and operating under the same pressure, a difference of head lost in friction in the return connections results in a difference of water level.

The discrepancy of water level from this cause remains practically constant, but the use of separate check valves introduces another cause for variation. When a check valve is closed, the area exposed to pressure on the outlet is more than on the inlet side by the projected area of the valve seat, hence when the valve closes, considerably

more pressure is required to open than to close it, and when opened it will not close until the total pressure on each side is almost equal—i.e., until the flow has practically ceased.

For separate checks to act in unison, they must not only be of the same size but they must be the same in areas of their seats, and at best, the alternate action of the checks results in see-sawing of the water levels—often with such wide variations from low-water line as to endanger the boilers. Sometimes the difficulty has been remedied by carefully weighting the check valves to compensate the variations, but this is only temporary, for with wear, a relative change of friction or of seating takes place and the variations of water level soon become as great as ever.

Since the difficulties from connections arranged, as in Fig. 2, are likely to arise during normal operation, it may be considered that there is less risk from an improper use of valves arranged as in Fig. 1 than from the use of a check valve on each boiler.

The serious objections to connections made as in Figs. 1 and 2 would seem to be obviated by arranging them as in Fig. 3. There, the returns are connected into the bottom of the main feed pipes, set at about the same height as the ordinary working water level of the boilers, the return connections to each boiler being provided with a return stop valve which should be closed when the boiler is idle, and a check valve should be located in the main return, as in Fig. 1. With this arrangement, if the attendant should shut off only the steam valve of a boiler while there was a tendency for the pressure to rise in that boiler, the water level could not be reduced below the level of the feed-pipe connection. No great harm could result, as the excess of pressure backing into the other boiler would probably cause a water-hammer and thereby warn the attendant of his neglecting to close the return stop valve of the idle boiler in advance of the time required for replenishing the water evaporated from the boiler continued in use.

The writer cannot testify to having tried the arrangement shown in Fig. 3, but he sees no reason why it is not feasible where two or more boilers are connected. This method of connecting the return pipe appears to be a good one for a single boiler, where there may be danger of the water level becoming reduced below the safe water line from closure of the steam stop valve.

Relays for Controlling Electrical Apparatus

By Charles C. Raitt.

SYNOPSIS—An explanation of the operation of protective relays of the simple overload, reverse-current, definite time-limit and inverse time-limit types; also relays for remote control of motors, switches, etc.

In its various forms the electromagnet is the most common means of producing the motion necessary for the automatic control of electrical apparatus. Among its principal applications are protective relays, controllers for elevator motors, large machine-tool motors and hand-operated relays for controlling distant apparatus.

Protective Relays

Protective relays are divided into classes according to the nature of the protection desired, these being: simple overload relays, reverse-current relays, definite time-limit relays for overload protection, inverse time-limit overload

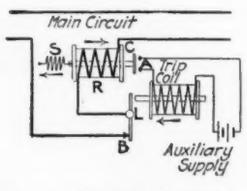


Fig. 1. Simple Overload Relay for Direct Current

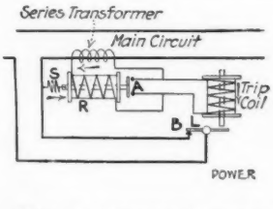


Fig. 2. Simple Overload Relay for Alternating Current

relays, and combinations of these. In general, it may be said that "make-contact" devices are used for protective relays when a reliable source of direct current is available, and "break-contact" devices when this is not the case.

There are two general types of simple overload relays in common use. If an auxiliary source of current is to be used for operating the tripping mechanism, a single coil relay may be placed in series with the main circuit and arranged to close the trip coil circuit when overload

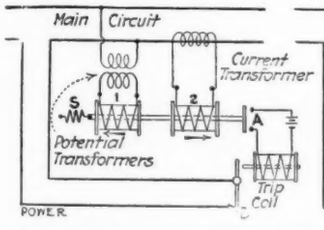


Fig. 3. Showing Overload Action

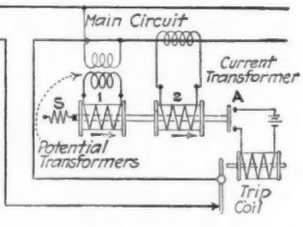


Fig. 4. Showing Reverse-Current Action

occurs, as shown diagrammatically in Fig. 1. The tension in the spring S is regulated according to the maximum value of current desired in the main power circuit. When this value is exceeded, the magnetic pull in the series relay R overcomes the force of the spring and causes the contact C to close the trip coil circuit at A. The tripping relay, in turn, presses on the lever L and opens the main circuit at B. This combination may be used for either alternating current or direct current. Often, as in the case of switchboard circuit-breakers, the auxiliary circuit is dispensed with entirely and the series relay is made to open the circuit directly.

For alternating-current circuits an alternative method may be used when there is no direct-current supply available; this is shown in Fig. 2. Here a series transformer is placed in the main circuit and two parallel circuits are taken from its secondary winding. To the first of these

circuits a relay R is connected, which normally short-circuits the second circuit, which is used for energizing the trip coil. When an overload occurs, the pull in R overcomes the force of the spring S and opens the short-circuiting switch at A. Current then passes from the transformer through the trip coil, causing the latter to press on the lever L and open the main circuit at B.

For circuits which require protection against continued overload, but in which it is important to maintain service, the possibility of interruption of service due to momentary overloads is avoided by using the time-limit overload relay. The function of this is to delay the opening of the circuit until any momentary overload may have had time to die out. If the overload continues, however, the circuit will be opened. There are two types of time-limit relays, the definite and the inverse time-limit relays.

The definite time-limit relay is commonly composed of a plunger magnet, a spring and a bellows. When overload occurs, the plunger moves through its complete path instantly, compressing the spring. The spring is in contact with the bellows, and the time required to compress the bellows is proportional only to the strength

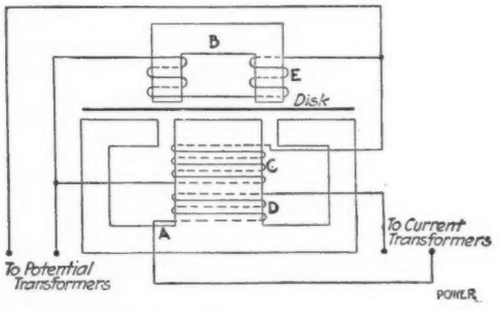


FIG. 5. INTEGRATING WATTMETER TYPE OF REVERSE-CURRENT, TIME-LIMIT RELAY

of the spring and is independent of the magnitude of the overload. Thus the time required to compress the bellows is always the same. The tripping mechanism is so arranged that the circuit will not be opened until the bellows is completely compressed.

The inverse time-limit overload relay may be constructed similarly to the definite time-limit relay, except that the spring is omitted. The plunger acts directly upon the bellows, and for this reason the time required to compress the bellows is now inversely proportional to the magnitude of the overload.

The time-limit action in these relays may be obtained in other ways, as, for instance, by substituting air or oil dashpots or the action of gravity for the bellows.

REVERSE-CURRENT RELAYS

Another type of direct-current, inverse time-limit relay is in common use for the protection of storage batteries and rotary converters against reversal of current. It is composed of a stationary coil and a rotating coil wound on an aluminum frame. The main feature of this relay is its reverse-current action. It gives no overload protection when the current is in the positive direction, but when the current in the circuit reverses, it causes the rotating coil to reverse. This reversal is opposed by eddy currents set up in the aluminum frame, which react against the flux in the moving coil and give the required inverse time-limit element. The trip coil contacts are so arranged as to operate the circuit-breaker when the rotating coil reverses.

Figs. 3 and 4 show an ingenious method of producing an alternating-current overload, reverse-current, inverse time-limit relay for single-phase operation. There are two coils wound on the same relay and so connected as to oppose each other under normal conditions. One coil is excited from a current transformer in the main circuit and the other from a potential transformer in the same circuit. Normally, the pull of the spring S and

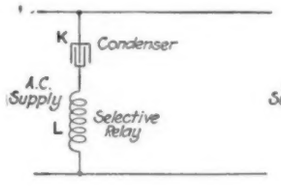


FIG. 6. SELECTIVE CONTROL RELAY FOR DIRECT CURRENT

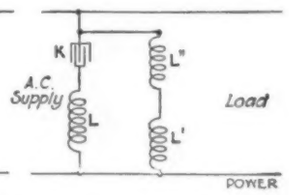


FIG. 7. SELECTIVE CONTROL RELAY FOR ALTERNATING CURRENT

the coil 1 are sufficient to overcome the action of the coil 2. When overload occurs, the strength of coil 2 is increased, while that of coil 1 is unchanged. Therefore, the plunger moves to the right, closing the trip-coil circuit at A, which in turn opens the main circuit at B.

If the line in which the relay is placed is operated in parallel with some other line and failure occurs between the relay and the generator, current will be fed back through the relay into the failure. In this case the current in coil 1 will be reversed, while that in coil 2 remains unchanged in direction, with the result that the two coils will combine to oppose the force of the spring S and operate the circuit-breaker. This relay is defective in that it is inoperative at the low power factor which obtains when there is a short-circuit on the line.

Still another common type of alternating-current overload, reverse-current, inverse time-limit relay is of the integrating wattmeter type, the essential features of which are shown in Fig. 5. As with the integrating wattmeter, there are permanent magnets above and below the rotating disk on one side and electro-magnets occupying the same position on the other side. The permanent magnets are not shown in Fig. 5. Whenever the torque in the disk becomes greater than that for which the relay is set the trip coil contacts are closed. The coils E and C are in parallel and D normally opposes them.

In case of overload, the strength of the coil D is increased, and this in turn increases the torque in the disk and opens the circuit. When the voltage drops, the coil C acts as a secondary for D and sends current through the coil E, this action again increasing the torque in the disk and opening the circuit. If failure occurs and current is fed back through the line, the current in E and C will be reversed and will combine with D to produce an excessive torque in the disk. The relay will act under all abnormal conditions.

CONTROLLERS

Controllers for elevators, large machine tools and such apparatus are usually of simple design, consisting of series of contactors, each of which not only performs its

primary function, but also controls the circuit which energizes the coil of the next contactor in the series. The primary functions of the contactors are determined by the requirements of the apparatus to be controlled, as, for instance, the cutting out of resistance, step by step, in starting a motor. The combining of contactors to produce a given result may become extremely involved, but the relays themselves are usually simple plunger or traction magnets, placed in series with the circuit to be controlled.

Hand-operated relays for controlling distant apparatus consist of control relays, operated by light currents, which in turn energize the plunger magnets, or start the motors which move the switching devices for power circuits. It has been customary up to the present to provide separate circuits for the control currents.

Recently, however, three Englishmen, W. Duddell, A. H. Dykes and H. W. Handcock, have succeeded in superimposing a control current on the main power lines, thus enabling them to control distant apparatus from a central point. The control current used is of high-frequency and low-voltage, and the effect which it produces on the main current is negligible.

Fig. 6 shows that with direct-current transmission lines, a selective relay on which the control current will act, but which will not be affected by the power current, is a simple arrangement. Of course, this is because direct current will not pass through the condenser.

With an alternating-current supply, the problem is not so simple. In Fig. 7, K is also a condenser, L is one of the relay coils, and L' another having the same number of turns, and wound on top of L'; L'' is a choke coil. The low-frequency current passes through the condenser K and is given a lead of 90 deg.; the other branch of the same current passes through L'' and is given a lag of 90 deg. The result is that the two branches cancel each other when they pass through L and L', respectively. The high-frequency ripple current passes the condenser, but will not pass the choke coil, therefore it is left to operate the relay.

Will Quizz, Jr.

SYNOPSIS—Will does not have a clear notion in regard to latent heat, total heat, etc., and takes advantage of his first opportunity to ask Chief Teller about them.

"Chief, what is this latent heat thing, and what is it like? And there's sensible heat, and B.t.u.'s and other things in the steam tables. I would like to get acquainted with the whole lot."

"Hold on, Will, don't go so fast. You can't get all of them in a job lot."

"Well, then, introduce me to some of them, anyway."

"To begin with, take the British thermal unit. That is its full name, but it usually goes by the initials B.t.u.

"In order to measure or weigh anything, we must first have a standard unit for that purpose, a pound or a foot, etc. In the same manner, in order to measure heat it is necessary to have a unit for its measurement. It is the amount of heat necessary to change 1 lb. of water 1 deg. in temperature. Water is used as the means to establish this unit because it is the most convenient at hand.

"Water does not change 1 deg. with the application of the same amount of heat at all points from 32 to 212, because water varies in density at different temperatures. For a long time a B.t.u. was specified as the amount of heat required to raise 1 lb. of water 1 deg. at the temperature of its maximum density (about 40 deg. F.). Later, it was decided that the fair basis would be the *average* amount of heat required to raise 1 lb. of water 1 deg. between 32 and 212, so in the Marks and Davis steam tables the B.t.u. is taken as $^1/_{180}$ (because 212 — 32 = 180) of the total heat required to raise water from 32 to 212 deg.

"*The sensible heat* is that heat which is absorbed by any substance in changing from one temperature to another without change of form. Any change of temperature without changing the physical condition of a substance, either liquid or solid, is called sensible heat. When heat is added which changes its physical condition from one state to another (for instance, changing water into steam), the sensible heat does not change during the process, but we know by reason of the continued application of heat to the substance that B.t.u. are being absorbed. This is called *latent heat,* because it does not appear in the form of changed temperature.

"*Latent heat* is the heat required to produce change of form or state without change of temperature.

"*Latent heat of steam* is the heat required to convert 1 lb. of water into steam under the same conditions of temperature and pressure.

"Now, the next question is, how many B.t.u. are necessary to convert a pound of water into steam at the same temperature? We have seen that it requires 180 B.t.u. to bring the water from 32 to 212 deg. Careful experiments by Regnault, about 1845, and others later, determined how many B.t.u. were used up in the process of evaporating a pound of water from and at 212 deg. and it has been established that, in an open vessel at about the sea level (or under 14.7 lb. absolute pressure), 970.4 B.t.u. are necessary.

"*The total heat* is all of the heat in the steam above 32 deg., or all the heat that would be required to raise water from 32 deg. to the boiling point (212 deg.), and then to convert it into steam. It is the sum of the *sensible* and *latent* heat.

"One pound of steam at 212 deg., and at atmospheric pressure, contains 1150.4 B.t.u. In other words, the 180 B.t.u. sensible heat and 970.4 B.t.u. latent heat equal 1150.4 B.tu. total heat.

"A good way to keep these things in mind is to think of a certain *quantity* of heat put into water to bring it to the boiling point (212 deg.)—which is sensible heat; then another *quantity* of heat required to evaporate the water into steam called latent heat of evaporation. Then, after all has been turned into steam, if more heat is applied, the steam becomes superheated and shows a higher temperature, which is sensible heat again.

"Well, Will, by this time you ought to feel somewhat acquainted with these members of the thermal family. Next time we get together we will discuss how this thermal family is related to mechanical energy."

Holding Strength of Stay-Bolts

By J. C. McCabe

A Scotch boiler which failed at the rear stay sheet by stripping all the stay-bolts, showed bulges between the stays of varying extent up to one-half an inch in some places. It was quite apparent that this bulging had been progressive and that the ends of the stay-bolts had been hammered up repeatedly to stop leakages. The plate was $\frac{15}{32}$ in. thick and was stayed with 1⅛-in. bolts pitched 7¼x7¼-in. centers. The safety valve was set at 105 lb. The plate should have given good service and longevity under that pressure if reasonable care had been taken to keep its surfaces clean.

Later several tests were made to determine the holding strength of stay-bolts in flat surfaces under normal conditions and in plates that were bulged, the stays in some cases having heads and in others without them. Following are the conditions and results obtained:

Stay-Bolt and Plate No. 1—This stay-bolt was 1⅛ in. diameter, with 12 threads per inch. The end, headed over in the customary manner, had a diameter of head of 1⅜ in. and a depth of ⅛ in. The material was regular stay-bolt stock. The plate was flat and the bolt fitted in the usual manner. This stay-bolt is of the same size as used in the boiler which failed. The following data are explanatory:

External diameter of stay, in.	1⅛
Diameter at bottom thread, in.	0.9807
Area section at bottom thread, in.	0.755
Pitch of stay-bolts, in.	7¼
Net area of stayed section, sq.in.	51.707

In the destruction test this stay-bolt reached the yield point at 29,100 lb. and failed by stripping the head when the load reached 46,140 lb., because of reduced diameter. The low-yield point was, no doubt, due to the yield on the threads. The pressure equal to the yield-point strain would be 564 lb. gage, and the gage pressure to cause ultimate destruction, as shown by the test, was 893 lb.

Stay-Bolt and Plate No. 2—This test was made to determine the comparative strength of a stay-bolt, without a head and in a buckled plate, with the same character of bolt and plate in first-class condition, as in test No. 1.

In test No. 2 the stay-bolt was of the same stock and size and made at the same time as No. 1. The plate was from the same piece as No. 1, but it had been dished about three-eighths of an inch, thereby enlarging the stay-bolt hole on one side. Under the test the bolt stripped at 24,800 lb., which gave an equivalent of about 483 lb. gage pressure.

The failure occurred under less strain than the yield point of No. 1, which was 564 lb. gage, and the ultimate strength was only about 54 per cent.

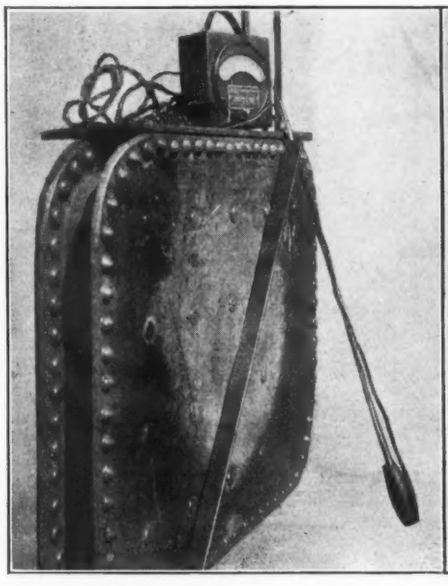


Fig. 1. Heated Plates with Bolts Headed Up

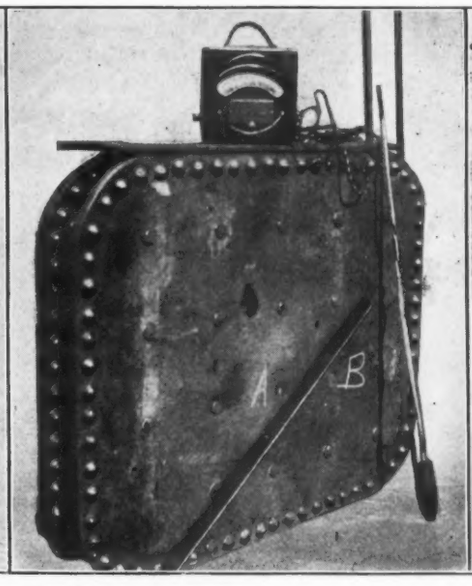


Fig. 2. Bolt *B* Had No Head

Fig. 3. Effect on the Thread from Bulging

Stay-Bolt and Plate No. 3—In this test a stay-bolt similar to Nos. 1 and 2 was used and headed over in the regulation way. The threads began to yield at 26,000 lb. and finally failed at 28,800. This gave a pressure of 522 lb. at the point where the threads began to yield, and 557 lb. at the limit.

This comparison of the three tests is self-explanatory:

	Ultimate Strength, Lb.
Test No. 1—Regular head, straight plate.	893
Test No. 2—No head, plate buckled ⅜ in.	483
Test No. 3—Regular head, plate buckled ⅜ in.	557

Stay-Bolt No. 2, Test No. 4—This stay-bolt had about ½ in. cut from its end after the test with a dished plate; it failed at 24,800 lb. It was then screwed into a new plate prepared like the defective boiler, with a buckle of ⅜ in. The end of the stay was screwed through and was flush with the plate. On the testing machine the stay stripped at 10,200 lb., which was about the same as a gage pressure of 196 lb. The value of the stay-bolt head is clearly indicated.

For the purpose of determining the behavior of a flat stayed surface under varying conditions of heat and pres-

sure, a steel ring was made up with a plate 0.447 in. thick on one side, having a yield point of 42,846 lb. (see laboratory report), and a plate 0.517 in. thick on the other side. The spacing of the stay-bolts was 7¼x7¼ in.

To determine the ultimate elastic strength of this plate, a hydrostatic pressure was applied, but before subjecting to pressure a straight-edge was applied to the 0.447 in. sheet, which disclosed that it was flat and true, except at the outside of the outer row of stays, leaving the central portion slightly prominent.

Under a pressure of 370 lb. a bulging between $\frac{1}{16}$ and ⅛ in. was noted, which disappeared on release of the pressure. The pressure was again applied, to 400 lb. gage, and on release a set of 0.02 in. was noted. The third time, the pressure was applied to 455 lb., and on release a set of ¼ in. was found between the stays.

The United States Bureau of Steam Engineering formula to ascertain the elastic strength as applied to this case is

$$\frac{42.846 \times 0.447^2}{(7.25 - 1.375)^2} \times 1\tfrac{1}{2} = 372 \text{ lb.}$$

The actual bulging pressure was between 372 and 400 lb., when a set of 0.02 in. was found.

In order to observe the effect of heat on a flat stayed surface similar in design to the defective boiler, an air pressure of 95 lb. was maintained on the sample and a flame was made to impinge against the surface. The plate, 0.447 in. thick, took a set at 1075 deg. F., Fig. 1, and the 0.517-in. plate took a set at 1275 deg. F.

Stay-Bolt B, Fig. 2—This stay was used in the test sample of stayed surface and stripped on threads at 95 lb. internal pressure at 800 deg. The inside threads showed that at the time of failure they had but small contact. This stay had its head cut off before the test.

Stay-Bolt A, Fig. 2—This stay-bolt was used in the test sample and it stripped under 95 lb. internal pressure, with a full head, when the plate was at 1275 deg. The greater bulging can be seen at *A*, Fig. 3.

The significance of this bulging is that the limit of elastic strength is about one-half the ultimate strength, and, at 98 lb. or thereabout, the stay would be on the balance as to strength of its threads (conditions considered), and any disturbance with a boiler pressure of 95 lb. would tend to disaster.

A vital factor in this problem lies in the destructive stresses induced in the stay-bolts by overheating the stay-plate and in the destructive movement on the threads. At times this plate had an expansion of about ⅝ in., and the effect was cumulative from the bottom toward the top. The sheet is held to the shell at the bottom by stays, but is free to expand upward.

As soon as bulging occurs between stays in a flat surface, a compression of the plate on the outer end of the stay-bolt occurs, while the plate draws away from the bolt on the inside. This greatly reduces the holding strength of the stay, so that often boilers are found in operation that are at the point of failure.

In dealing with flat surfaces where plates are buckled, new stays should be installed immediately and care should be taken that they have a substantial head, well formed, or, preferably, the stays should be made with a tapered thread for insertion from the fire side of the plate into a hole suitably threaded for the bolt. This would enable the boiler maker to fill the threaded hole solidly before heading the bolt over. The present methods are somewhat lax, owing to the desire to speed up on construction.

Fig. 3 shows the inside of the pl te after the foregoing test. Stay-bolt holes at *A* and *B* are for the same stays as in Fig. 2. Stay-bolt *C* shows the effect of the bulging between stays.

Samples of what was once an excellent quality of firebox steel disclosed that it was unsafe for use in a boiler because of destructive internal strains caused by forming up the plates.

It would seem that the time is at hand for a radical departure in boiler-shop and plate-mill methods and for a great reduction effected in boiler failures. It is misleading to depend on increased factors of safety only when the very methods of manufacture tend to strain the materials far beyond the elastic limit in the initial steps of the shop work. In the case of a horizontal-tubular boiler made from ½-in. plate and rolled up cold in the ordinary manner, the outer surface will elongate over 1½ in., while the inner surface will shorten about the same amount. We thus produce a change in the entire plate, because the outer half is under a tension strain and the inner half is under a compression load. Assuming that the courses of a 72-in. boiler are uniform in strength throughout its circumference and it is formed without the strains referred to, it would require an internal

SAMPLE OF 1/32" Boiler Plate Fracture ANALYSIS NO. 7586 7

ANALYZED BY

THE DETROIT TESTING LABORATORY

DETROIT, MICH.

FOR John A. Weeks, Mt. Clemens, Mich. — 19—

Re. Mt. Clemens Sugar Co.

DIMENSIONS OF BAR = 1.50" X .447" .6705 sq in

ELASTIC LIMIT PER SQUARE INCH = 42846 lbs

TENSILE STRENGTH PER SQUARE INCH = 62599 lbs

ELONGATION IN 2" %

REDUCTION IN AREA (1.03 X .3) = 53.9 %

FORM 2—12-10-DM.—T & C.

REPRODUCTION OF LABORATORY REPORT CARD

pressure of over 600 lb. to induce metal changes equal in extent to that produced by rolling; the limit of strength would be upward of 800 lb., and the working pressure upward of 160 lb.

Does it not seem peculiar that boiler materials must be strained to a destructive point before even assembling them. Increasing the factor of safety is in a measure nullified by the increased change in metal necessary on account of rolling thicker plates and the possibilities due to the segregated metaloids.

It is the writer's opinion that the time is not far distant when the rolling mills will furnish boiler sections rolled to the desired diameter and thickness, at a price less than the present cost of plate and shop work.

A 40,000-Hp. Steam Turbine has recently been completed in the shops of Brown, Boveri & Co., Mannheim, for the Mark Communal Electricity Works Co., of Hagen. It is designed to use steam at 50° C. (662° F.), and 12½ atmospheres (184 lb.) pressure, which means 287 Fahrenheit degrees of superheat. The speed is 1000 r.p.m., and the generator produces three-phase current at 11,000 volts and 50 cycles. The length of the set is 16 m. (52.5 ft.), and the width 4.2 m. (13.8 ft.), the total weight being 385 tons with condensing plant.

Editorials

Industrial Education and the Engineer

Circumstances are increasing the necessity for training men for the activities of life at the expense of the public. The changes which have come about through the introduction of the factory system of manufacture, where an operative tends only one machine, and where it is neither possible nor profitable for a shop to train its own skilled mechanics except by establishing a school within its own shop, all have had a vital bearing on this question.

This particular influence has no great bearing on the training of young engineers. A man in the power plant is valuable, not for his ability to do some one thing quickly and well but for his ability to do many things well and to think his way through troubles before they reach him. He must cross his bridges before he comes to them, even if he has to shatter a time-worn proverb to do it. From this one fact it is evident that the problem of industrial education for the power-plant operator is different from that for the machinist or the cabinet maker. A machinist who is dexterous, can get along even on a job that he had never done before. Although when properly trained he should be an all-around machinist, the man who learns to do only one or two things well has a place in life and may earn a fair living. A power-plant man whose abilities were marked along only one line would be hard put to it to find a job at all, much more to find one that paid well. Even if employers might risk hiring him, state laws step in and insist that he shall have a fairly good all-around development. This is likely to increase rather than diminish as the complexity of the work increases.

Twenty-five years ago, a power plant consisted of a boiler running at a low pressure, an engine operating under what we would call easy conditions today, and a pair of pumps, possibly a condenser, and surely a gravity-return exhaust steam-heating system. A boy who had fired for a time, and who was bright enough to become familiar with the simple piping layout, could be trusted to keep up steam and keep the engine turning over. Fortunately, there was never a machine that would stand more abuse than a slide-valve engine and still keep going if supplied with enough steam.

Now, that is all changed. Except for sawmill engines, where it is cheaper to burn sawdust under the boiler than to dispose of it any other way, it is necessary to make every pound of coal produce results. The engine speed must be just right, particularly if it is directly connected to an alternator and is one of a number that must keep step. The transmission lines, the lighting lines, the motors and transformers, a vacuum-heating system and a thousand and one things that our fathers never had to worry about, are all present, not merely in isolated places, but in almost every plant even of small size. This means that an engineer now must possess considerable technical knowledge. Dexterity has sunk to comparatively small importance.

It might be guessed from this that, to be an engineer, one should be a graduate of a technical school. Few technical graduates want such jobs at all; their education leads away from positions requiring the restraints that an engineer must practice. The work does not attract them because there is too much additional training ahead before they can get and hold a responsible position, in spite of the considerable study of power and transmission subjects in school. The work given is so universally approached from its theoretical aspects rather than from its practical ones that it is necessary for the graduates to begin all over from the other side of the question. This comes about in turn through available textbooks. In any small college, it is perfectly possible for anyone with a good general education and a textbook to teach steamwork at short notice. If he is an operating engineer, he may start out with the determination that he will teach it as it is and let the textbooks slide, but he soon finds that the head of the department or the president can only think in terms of textbooks, and as that is the line of least resistance, he follows it. Probably, if he persisted in doing what he knows is right, there would be a vacancy the next year, so he cannot be much blamed.

If engineers cannot be trained in technical schools, where should they be trained? Practice in one plant is not enough today. There are no two plants alike. No one without a knowledge of fundamental principles can shift from one to another without embarrassment, which may mean serious injury to the plant. The teaching of fundamental principles is an educational proposition. We are also coming to feel that training in the practice of a trade is also a school job. Since the technical schools have undertaken another part of the world's educational work, it will be necessary to establish new schools if this work is to be done in them. This has already been attempted in a small way. There are seven states which have by law made it possible that trade schools should be established by cities and aided by the states themselves. Massachusetts has taken the lead in this form of education and the account of the work there being undertaken as given by E. H. Fish, on page 153, will be found to present a serious problem, well deserving attention and discussion.

Important Court Decision

The recent court decision in the case of Perceval vs. the New York Edison Co. (see page 153) has far greater significance than its bearing on the particular case involved, for, if the decision stands, it will invalidate the clause in the present contracts which stipulates that no other electric service shall be introduced or used without the consent of the Edison Co. This clause, sanctioned by the Public Service Commission, has proved an effective weapon against the block plant and its elimination would probably result in greater use of this system, which, under many conditions, is admittedly the most economical method of electrical supply.

In the case at hand, there were two adjoining buildings, one having a plant with sufficient excess capacity to supply the second building, thereby raising the load factor and reducing the cost of generating electricity. This made it possible for the management to sell to its neighbor at a lower rate than the latter could buy from the Edison Co. Conditions were such, however, as to make it desirable to use this service during the day and Edison breakdown service at night.

The Edison Co., in refusing to supply the service, claimed that the private plant was a competitor and that it should not be compelled to furnish breakdown service for a competitor; this contention was upheld by the Public Service Commission. Had the case been advanced on the grounds that the service demanded was for a peak-load period, a special rate might have been justified; instead, the contention was that the consumer must take all his energy from the Edison Co. or go without it.

In reversing the opinion of the Commission, the court held that the clause under discussion was an arbitrary attempt on the part of the company to establish a monopoly and was in no way a regulation with respect to the service. It further maintained that the Edison Co., in lieu of the privileges granted by the city, especially the use of the public highways, is bound to serve impartially every member of the community who demands service, providing, of course, that the mains are within a reasonable distance of the applicant's premises.

In the light of this ruling, the private plant could hardly be treated as a competitor of the central station, as it does not receive any special privileges from the city and does not use the public streets, the supplying of electricity to the adjacent building being merely a business transaction between two private individuals on their own premises.

The New Table of Contents

All but our very new subscribers know that for many years and until the first of this year, certain of the reading matter in POWER was grouped in departments, namely, Electrical, Gas-Power, Heating and Ventilating and Refrigeration. For greater convenience in making up the paper, and to enable a better selection without the restrictions the old practice imposed, the department arrangement was abandoned at the beginning of the last volume (Vol. 39).

The only serious objection to the change was that it was no longer so easy to pick out the matter in which one may be especially interested. To remove this fault, we have modified the manner of presenting the table of contents on the first page inside of the cover, and beginning with this issue the contents will be classified not only in the former departments, but with still greater subdivision into such general heads as seem appropriate.

Instead of being classified under "Correspondence," the letters, although still printed all together, will be indexed like any other short articles. As before the more important articles will be summarized.

We shall be glad to entertain criticisms and suggestions regarding the new arrangement with a view to further improving it. The readers can tell better than we can what they do find or would find most convenient.

Individual Stacks

That one-stack-to-a-boiler idea in the Moline plant (described on pages 118-124) is a matter of interest for its unusualness, if nothing else. Almost nowhere but on a rolling mill or steel works can such a "forest of stacks," as it is aptly called, be found. While, similarly as the sectional bookcase, the individual chimney may facilitate extensions of the equipment and there may be other advantages, as mentioned in the article, it probably would not be safe to commend it as the best practice. This plant is already contemplating the substitution of four stacks of equivalent area when any further accessions are made to the boiler plant. Just as group drive proved the compromise between one motor to the shop and one motor to each tool, it will be found that one stack to a certain number of boilers or about a certain boiler horsepower will be the happy medium between the single monstrous chimney and one for each boiler.

So called waste material is in reality good material in the wrong place.

The index of POWER for the first half of 1914, Volume 39, is now ready. Copies will be sent, without charge, upon request in writing.

Ailments of the power plant are sometimes dealt with by the auto-suggestion method or by absent treatment, but the best results are usually obtained by the laying on of hands with the proper zeal and mental condition.

The cartoon this week, while mainly intended to amuse, typifies feelings many of us have had, one time or another. If we could, we would throw the poor coal back on the company that sold it to us. Those of us who buy our coal on specification can come pretty near following out the example of the picture, figuratively.

Professor Olaf Heggstad, in a recent lecture, said that the rights of the Rjukanfos, which by next year will be able to produce more than 250,000 horsepower, were sold in 1890 for £55 10s. In making up the charges to the consumer, will interest and profit be asked for on this amount or on a bloated estimate of the present value of the franchise?

A large number of inquiries are received by this paper weekly, some of which are of a general nature and can be answered with a few words on our "Inquiries of General Interest" page. Others deal with special and individual questions which would not interest the readers in general; these are answered by mail when they are not too involved, for we cannot furnish a consulting engineering service for two dollars a year. There is still another class, whose answers would require more space than can be allowed on the inquiries page and would moreover, admit of differences of opinion. These we intend to print from time to time for the discussion of our readers. It will often be impossible to print all the answers, but in deciding which shall be printed, the character of the discussion and the date of its receipt will be governing considerations.

Correspondence

Trouble in Starting Gas Engine

Trouble was experienced in starting a 600-hp., four-cylinder, four-stroke-cycle gas engine running on natural gas. It had been down for repairs over Sunday and an attempt was made to start on Monday morning with three cylinders, the fourth, which was out of commission, happening to be one of the air cylinders, thus leaving one air and two working cylinders for starting.

After several unsuccessful attempts, it was thought that the trouble was with the gas. The gas valves were reset and the admission and exhaust valves examined and found all right, but the engine still refused to start.

Finally it was decided to put some heavy cylinder oil in the cylinders, and after putting about one quart in each cylinder an attempt was again made to start, and this time with success, proving there was not enough compression.

R. G. Curren, Jr.

Kittanning, Penn.

Piping Troubles

The conditions described here were actually found in practice. At a generating station in a loft building, one engine had a bent crankshaft and a broken bearing. The cause was not hard to find; the engine was over a hundred feet from the boiler and there was no separator in the steam line.

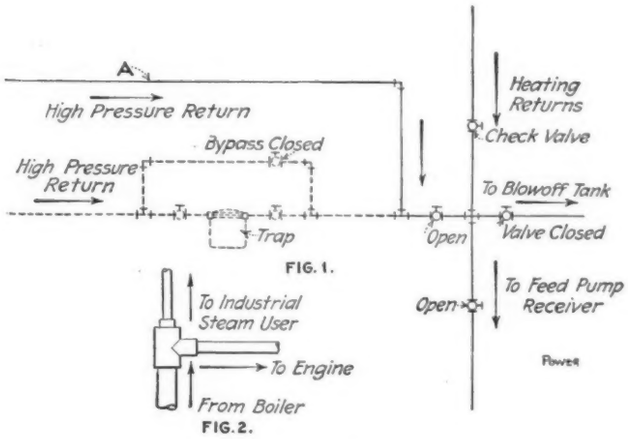


FIG. 1.

FIG. 2.

Faulty Piping

In another plant where high-pressure steam was used throughout the building for industrial purposes, some of the tenants complained about the poor heating service. The piping was followed out and appeared to be correct until the junction of the return pipes, Fig. 1, was reached. Here the high-pressure return pipe line *A* was not trapped, so that high-pressure steam went directly into the pump receiver. This pressure on the discharge side of the check valve prevented the return of the heating condensate and caused the pump to knock. A trap, shown in dotted lines, placed in this line removed the difficulty.

Guests who were unfortunate enough to occupy rooms near the water line in a certain large hotel, never willingly occupied them again. The water was pumped through this line to the roof house tank by a geared triplex pump, and when it was in operation the noise was transmitted along the entire line. This was stopped by cutting about four feet of pipe out of the line near the pump and substituting a strong rubber hose, securely fastened at each end.

Another interesting case, Fig. 2, was found in a plant which carried 95 lb. pressure at the boilers, but could not get more than 90 lb. on its industrial steam system. The pressure was taken from the line which supplied the engine instead of from the boiler direct.

Albert H. Israel.

New York City.

Peculiar Experience with Graphite

On opening a water-tube boiler in which I have been using graphite, I found in the front water leg about 1½ gal. of black balls ranging in size from a small marble to a walnut.

I have been using graphite in the same boilers and feeding it through the heater in the same way for the past year, but this is the first time it has balled up in this fashion. The last shipment, which has been used for about a month, may be of a grade different from that formerly employed. Some engineers think that when a boiler is once coated with scale, graphite will not loosen it up; this is not my experience.

About a year ago, the boilers were coated with $\frac{1}{16}$-in. scale. I used graphite for four months and the scale dissolved and disappeared. On the boiler inspector's last trip he congratulated me on the good condition of the boilers; said they looked like new. I have found no bad effects from the use of graphite.

W. H. Corbin.

Sharples, W. Va.

Babbitting a Crosshead Shoe

It became necessary to babbittt one of the crosshead shoes of a vertical ammonia compressor. Our lathe was not big enough to swing it, we decided to babbitt it in place.

The crosshead was brought up nearly to the top of the guides and carefully centered. The connecting-rod was disconnected and the defective shoe taken out. The old babbitt was chipped out and the shell cleaned with gasoline and put back in place on the crosshead. The adjusting wedge was set so as to bring it as close as possible to the crosshead to allow the maximum amount of metal between it and guide.

The good shoe was then brought tightly against the

guide by placing blocks of wood against the piston rod on the opposite side and using wedges to tighten them.

Pieces of one-inch board about three inches wide and a little longer than the shell were placed on each side and wedged in place. A piece was formed to the shape of the guide and blocked in place at the lower end. The openings and joints were filled with fire clay and the metal poured in until it came up even with the top of of the shoe.

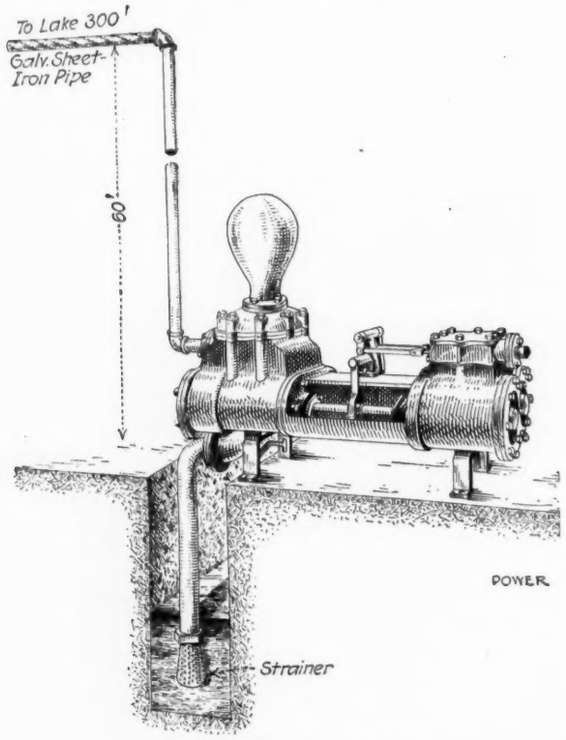
When it had cooled the shoe was taken out, scraped and trimmed, and put back in place and adjusted to an easy-running fit. It has been running since then without trouble.

THOMAS G. THURSTON.

Chicago, Ill.

Air-Pressure Collapsed Thin Pipe

A curious accident happened to the discharge pipe of a pump located in a large, deep well to remove the surface water while digging. From the pump to the top of the well, standard iron pipe was used, and from the well to a lake, a distance of 300 ft., at a slight elevation, 6-in. galvanized sheet-iron pipe of No. 20 gage was used. All went well for several days until it was necessary to stop the pump on account of trouble in the water end. No provision was made for gradually draining the pipe, so that when the pump head was removed the rush of



DISCHARGE PIPE COLLAPSED

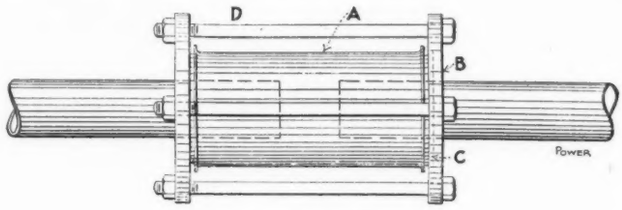
water down the pipe formed a partial vacuum in the line, which caused about 50 ft. of the sheet-iron pipe to collapse, so that it had the appearance of having been run between a pair of rolls. A wooden trough was substituted and further trouble was obviated.

JOHN F. HURST.

Louisville, Ky.

An Emergency Pipe Repair

The discharge pipe leading from a pump, which was used to drain a pit, was accidentally broken at a joint. It was decided that the best way to repair it would be as follows, because the pipe was of odd size and no special fittings could be found.



REPAIR JOB COMPLETED

A piece of pipe *A* of slightly larger diameter than the one to be repaired was cut off and heated so it could be flared out at the ends. Two plates *B* were bored out to fit over the smaller pipe and drilled for the four bolts *D*. This rig was put on the pipe as shown, packing *C* was inserted and the bolts drawn up snug. When the water was turned on, there was no leakage and the job was satisfactory.

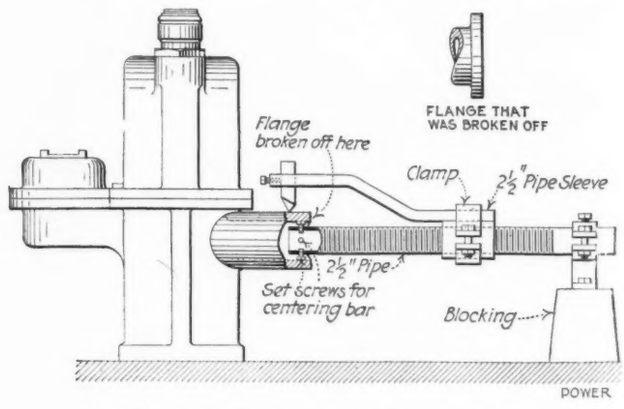
EARL PAGETT.

Coffeyville, Kan.

Repairing a Turbine Steam Connection

The illustration shows the rig we used for threading a turbine inlet and refitting a flange broken off by severe water-hammer in the steam line.

The flange and inlet neck were cast with the lower half of the turbine. As there was no machine shop available with a lathe large enough to swing the base, we decided



RIG FOR TRUING AND THREADING

to do the job as shown, and did not have to dismantle the machine.

A 2½-inch pipe was used for a bar. A toolholder was attached to an ordinary pipe sleeve that worked on a running thread on the pipe. The bar was centered by the setscrews at the end. The tool was ground flat and turned with a wrench on the sleeve, and the neck turned to size ready to thread. Then the tool was ground V shape and a standard pipe thread cut.

The same flange that had been broken off was bored out and threaded to fit the neck. When the job was completed it carried 175 pounds steam pressure and was entirely satisfactory.

FORREST A. JONES.

Minneapolis, Minn.

Sawtoothed Boiler Joints

At a recent meeting of the Engineers' Club of Boston reported in the June 2 issue, page 794, reference was made by a speaker to sawtooth straps for boiler seams. Since such straps are not commonly employed in boiler designs in the United States, an examination of the reasons for their use may be of interest.

Boiler seams must be tight to prevent leakage and strong to resist the tendency for the internal pressure to rupture them. Since the joints are made tight by calking the edge of one sheet against another, the two sheets must be held together rigidly enough to make the calking a success. This necessitates close spacing of the rivets, so that the plates will not spring apart at the calking edge when the calking is done. The calking edge of a seam, where the plates do not fit together properly, is about as in Fig. 1, the metal along the overlapping edge of the plate at *A* being upset until it presses closely enough against the lower plate to make a watertight joint. For a given thickness of plate, the pitch of rivets *B*, Fig. 1, and the distance from the edge of the

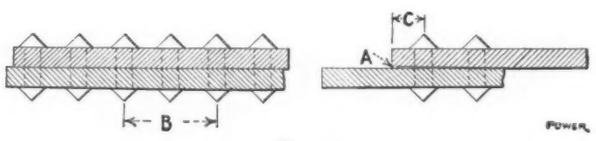


FIG. 1

plate *C* determine whether the seam can be successfully calked.

The size of the rivet heads is also a factor, for they support the plate rigidly up to the edge of the heads. These three factors determine the practical limit for the pitch of rivets for boiler seams: thickness of plate, size of rivets (which determines the size of heads), and the distance the rivets are placed from the calking edge of the plate or strap. The distance of the rivet from the edge of the plate is fixed in the case of longitudinal seams by the necessity for providing sufficient metal in front of the rivets to prevent them from pulling out through the edge of the plate or strap, instead of shearing the rivets or causing the net section to break.

This requirement causes the dimension *C*, Fig. 1, to be made one and one-half rivet diameters. It should be noted that the span *B* between the rivets affects the stiffness of the sheet as well as that of the calking edge, and along this plate, it is just as important in producing a tight joint as is the stiffness of the calking edge. For this reason, double butt-strapped joints can be successfully calked with a longer pitch between rivets, due to the support given the plate by the inner strap of the joint.

Many years ago, when butt-strapped joints were first used for boiler construction, the two straps placed on each side of the shell were made the same width, and as the rivet spacing along the outer edge of the strap had to be close enough to permit tight calking, joints of high efficiency could not be obtained with this design. In the United States, this difficulty was solved by making the inner strap wider than the outer, so that the calking edge would come where the rivets were spaced closely. Fig. 2 shows the double-strapped joint with the two straps the same width; it will be seen that the rivet spacing in the outer row along *A* and *B* will be determined by the thickness of the strap *t* and the distance of the rivets from the edge of the strap *L*. The efficiency of this type of joint exceeds comparatively little that of a double-riveted lap joint, on account of the limitation to the rivet spacing along the calking edge. The modification of this joint used in the United States to overcome the defect of low efficiency is shown in Fig. 3, where the outer strap is narrower than the inner, and the rivet pitch in the outer row has practically nothing to do with the stiffness of the calking edge on the outer strap.

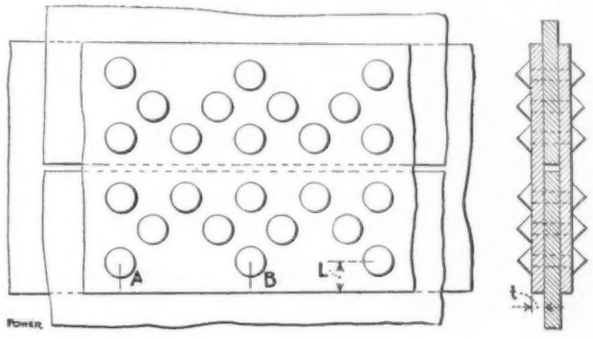


FIG. 2

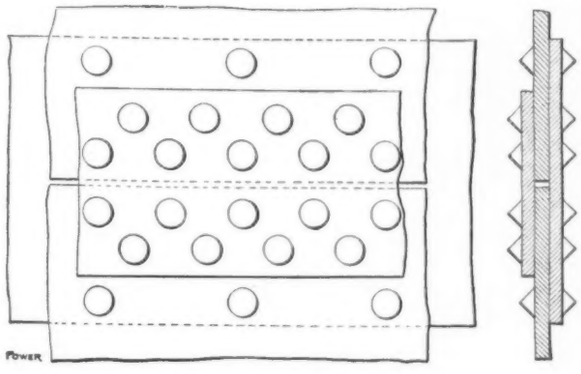


FIG. 3

Foreign boiler manufacturers do not seem to favor this style of joint; they use the kind having the two straps made the same width. The low efficiency has been practically overcome by serrating the edges of the other strap, as in Fig. 4, which illustrates a quadruple joint of this style.

It is difficult to see just what advantage the joint shown in Fig. 4 has over that in Fig. 3. The claim is that the strain due to the circumferential pull is not on one side of the joint, as is stated to be the case with joints like Fig. 3, where one of the straps is wider than its mate. The outer butt-strap in Fig. 4 removed the defect of the long span between rivets on the calking edge which existed in the seams made like Fig. 2 when they were designed for maximum efficiency. The style of joint shown in Fig. 4 requires usually that the outer straps be better fitted to the shell than in either of the

other styles shown to produce a tight seam without excessive calking. This can hardly be called an objection if good fitting is demanded rather than excessive calking. It is comparatively easy to fit the outer straps on joints shown in Figs. 2 and 3, so that the calking edges of the straps will be tight against the shell, but since the calking edge of the strap shown in Fig. 4 extends practically half way across its width, the strap and the shell must fit properly across this space unless excessive calking is to be required.

A difficulty occasioned by the use of straps as shown in Fig. 4 is that the calking edge cannot be planed, and since this edge must be machined to make it the proper shape to permit successful calking and to remove the defective material, it is necessary to resort to milling these

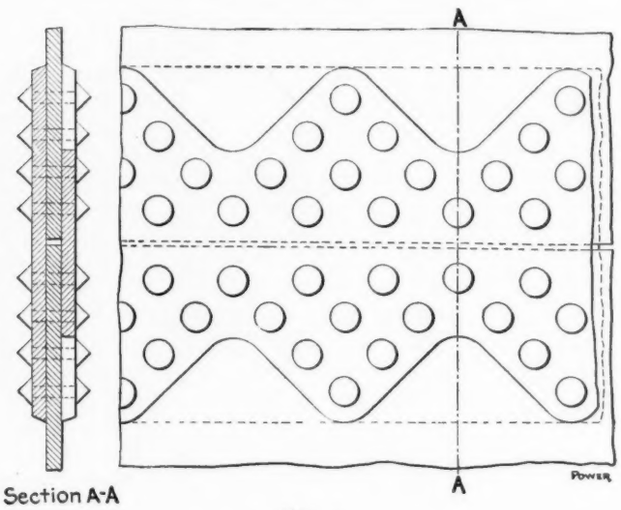


FIG. 4

edges, where the serrated edges have been formed when punching the plate out.

Since failures have occurred in joints, where the straps were of both equal and unequal width, the American practice, Fig. 3, may be considered the best type of joint for boiler design. The style of joint in Fig. 4 is largely used by German designers and undoubtedly originated in Germany. The one in Fig. 3 was originated by the Hartford Steam Boiler Inspection & Insurance Co.

S. F. JETER.

Hartford, Conn.

Saving in Coal Handling

Poor management in handling coal from cars to storage is a frequent cause of loss. I have had occasion to correct some of these losses, and in each case there has been not only a financial gain, but a saving of time and labor in handling a given amount of coal.

In one case, where facilities had originally been provided for using hopper dump cars, the management had permitted the shipping of coal in flat-bottom and side dumping cars to such an extent as to greatly increase the cost of handling. At another plant, where the storage was along the track, wheelbarrows transferred the coal 50 to 75 feet, where it was again shoveled into the small boiler-room car, from which it was fired. By extending this small rai ltrack and installing a switch, the cars were run anywhere in the coal-storage, thus saving the transfer from wheelbarrow to car.

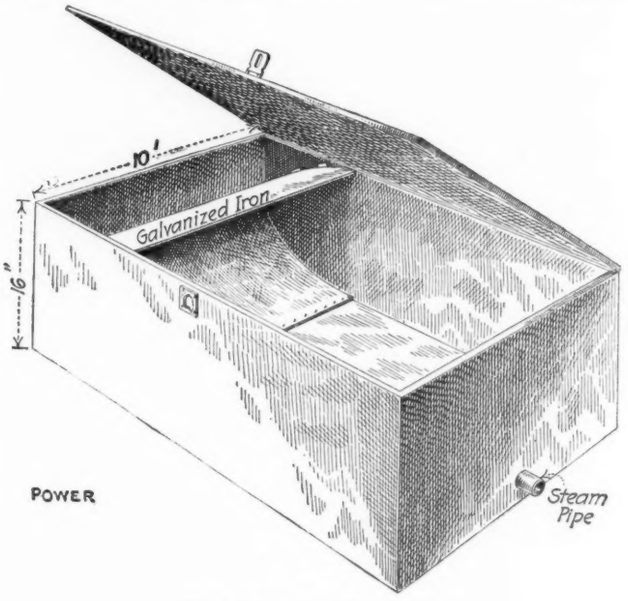
I have found it best for this class of work to employ husky laborers who can use large scoops, and to pay them by the ton for unloading. A good shoveler can make excellent wages at 12 cents per ton when unloading from the ordinary car.

B. W. DENNIS.

Columbus. Ohio.

Steam Washer for the Plant

This washer for oversuits is made out of a store box. I put a sheet of galvanized iron in one end to make a



THE WASHER COMPLETE

half circle. Then I hinged on a lid and attached a ¾-in. pipe to be connected to a steam hose. I put in one garment at a time; then close the lid and turn on the steam for 3 or 4 min. This will turn them over and over and boil all the grease out.

EARL W. COOK.

Cherry Tree, Penn.

Keeper for Valve-Gear Keys

Engines of the Corliss type should have the valve-gear keys held in place by keepers which will prevent the keys from working entirely out while running. The keys giving the most trouble on engines of the older makes (with long dashpot rods) are those on the steam-valve stems, probably due to the vibration of the dashpot.

In refrigerating or central-station plants, where it is inconvenient to shut down to replace a key, this can be done, without shutting down, if the engine is not overloaded, by simply shortening up the dashpot rod until the steam hook ceases to engage the valve arm. With this at rest the key can be replaced and the dashpot rod lengthened again until engagement takes place. This operation will probably be attended by some variation or racing, but this is preferable to a shutdown.

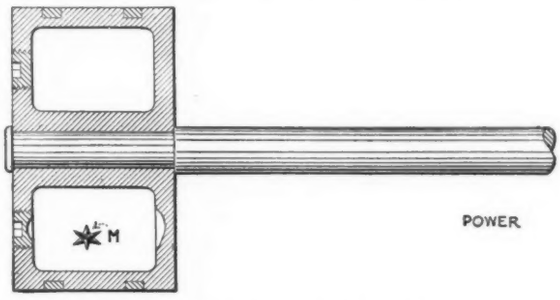
JOHN F. HURST.

Louisville, Ky.

Core Cleaner Left in Piston

Soon after a new piston was made for a high-speed engine, the latter developed a slight click in the cylinder. The shop man was called in and found that one of the pipe plugs that stopped the core holes was leaking.

A new one was put in, but in a few days trouble again



CORE CLEANER LEFT IN NEW PISTON

developed. This time the pipe plug, which was of the countersink kind, had a considerable opening in it, so it was taken out. Inside the piston head, there was a chilled cast-iron star which is used by foundrymen for cleaning hollow castings. The constant motion was causing it to cut its way through the piston head, the rear wall being nearly cut through. I have known of several engines being wrecked from such a cause, even when the click was only slight.

C. R. McGAHEY.

Baltimore, Md.

Operating Costs of a Small Oil-Engine Plant

The editorial in the June 3 issue regarding the use of oil engines is timely, and the subject is deserving of serious attention. However, it should not be assumed that the oil engine is an untried prime mover, for in the West and Southwest there are innumerable plants, both large and small, depending upon oil engines for power. As for service, these engines are fully as reliable as steam engines and the plant far less complicated.

Following is the monthly record of a small light and water plant in Texas, using a distillate oil engine driving a dynamo and a duplex power pump:

OPERATING COSTS

Engine	50-hp., three-cylinder vertical
Generator	30-kv.a. alternator
Pump	6x10-in. duplex power pump
Total kw.-hr. during month	2920
Total hours in operation	182
Average kilowatts per hour	16.15
Water pumped per month, gallons	1,820,000
Pumping head, feet	140
Electrical horsepower (assuming 90% efficiency of dynamo)	4,350
Water horsepower-hours (assuming 60% efficiency of pump)	1,786
Total brake horsepower	6,136
Distillate oil used, gallons	840
Cost of oil at 4½c	$37.80
Gasoline used (starting engine, etc)	50 gal.
Cost of gasoline at 10c	$5.00
Cost of lubricating oil (20 gal. at 35c.)	7.00
Cost of waste (10 lb. at 15c.)	1.50
Engineer's wages per month	70.00
Total operating cost	121.30
Cost per brake horsepower-hour	0.0198

It will be noted that the engine was but little more than half loaded. Consequently the fuel cost per horsepower-hour is higher than if running on a heavier load. Even under these conditions the fuel cost per horsepower is much lower than in the same size steam plant. As for reliability, after the first week, the engineer, who had never operated an oil engine before, had absolutely no trouble either in starting or operating the engine.

L. H. MORRIS.

Waco, Texas.

Parallel Field Connections

The proprietor of a steam laundry, becoming impressed with the economy that would result from generating his own electricity for lighting, purchased a small second-hand shunt-wound generator.

The engineer who was engaged to install the dynamo recommended a larger pulley for the countershaft, from which the dryamo was driven, so that it might run at the required speed. The owner, however, refused to make any further outlay, saying that he would cancel the arrangement unless the machine could be installed without the purchase of a pulley. After a conference with an electrician, the engineer changed the field connections from series to parallel so as to attain the desired voltage at the slower speed. The owner was satisfied, but did not know that the field was taking over twice the former current for excitation and that the electrical energy wasted would soon pay for a pulley.

T. H. REARDON.

Pittsfield, Mass.

Questions for Discussion

1. I would like the readers to give two sketches of the connections to furnish the following voltages from a bank of single-phase transformers on a 2300-volt, three-phase, three-wire primary. The first sketch should show two single-phase transformers in parallel, furnishing three-phase current at 220 volts, and a three-phase, 110-volt and 220-110 three-wire combination. These transformers must furnish all this at the same time. The second sketch should show the same combination with three single-phase transformers in parallel and in a bank.

C. D.

2. A 50-hp. General Electric, three-phase, alternating-current induction motor is wound for 440 volts; it is desired to change to 220 volts. What changes will be necessary in the windings?

M. F.

3. I intend to test the flue gases of four horizontal, return-tubular boilers burning No. 3 buckwheat coal under forced draft. These boilers are forced to carry the load while two other boilers are being reset. If I find only 5 to 8 per cent. of CO_2 in the gases, this will show excess air. If I then slow down the fans to raise the CO_2, will the boilers steam any better or as good as before? In slowing down the fans to reduce the excess air, could I hold the pressure?

J. M.

4. Believing that Corliss engines should work satisfactorily under a moderate degree of superheat, I should like to hear from readers who have had experience with such cases.

G. U.

Engineers' Study Course

Elementary Mechanics--XIX

Last Lesson's Answers

81. The acceleration due to gravity decreases the farther the body is from the center of the earth; that is, the acceleration of a body at the top of a mountain would be less than at the sea level.

82. Since the body is falling with an acceleration of 32.16 ft. per sec. per sec., the velocity at the end of 4 sec. will be

$$4 \times 32.16 = 128.6 \text{ ft. per sec.}$$

The average velocity during the entire 4 sec. was the sum of the initial and final velocities divided by 2, or

$$\frac{0 + 128.6}{2} = 64.3 \text{ ft. per sec.}$$

Therefore the body must have fallen

$$4 \times 64.3 = 257.2 \text{ ft.,}$$

which distance equals the height of the stack.

83. The time that will elapse before the velocity of the body becomes zero may be found from equation (44), where $T_1 = \frac{U}{g}$. In this case $U = 84$. ft. per sec. and $g = 32.16$, hence

$$T_1 = \frac{84}{32.16} = 2.6 \text{ sec.}$$

84. The vertical distance through which an object falls, due to gravity, is given by equation (42), where $H = \frac{1}{2} gT_1^2$. If the time is 2 sec., the distance H will equal

$$\frac{1}{2} \times 32.16 \times 2^2 = 64.32 \text{ ft.}$$

In problem 82 the height of the stack was found to be 257.2 ft., hence at the end of the second second the object was

$$257.2 - 64.32 = 192.9 \text{ ft.}$$

from the ground. This shows that the object in the first two seconds (one-half the total time of flight) falls a distance of only ¼ the height of the stack.

85. From equation (43) $V^2 = 2gH$. The velocity of the water emerging from the base of the standpipe will then equal the $\sqrt{2gH}$, or

$$\sqrt{2 \times 32.16 \times 50} = 56.7 \text{ ft. per sec.}$$

Falling Bodies (Continued)

The statement made at the close of the last lesson may be proved by substituting the proper values of a and S in equation (38). If a body is projected vertically upward, and then falls back to its starting point, evidently the net space passed over is zero and hence the value of S in equation (38) becomes zero. Therefore, when $S = O$ and $a = g$, there results

$$S = UT - \tfrac{1}{2} aT^2$$

or

$$O = UT - \tfrac{1}{2} gT^2$$

and

$$UT = \tfrac{1}{2} gT^2$$

hence,

$$T = \frac{2U}{g}$$

where T represents the whole time of flight.

In the example just solved, it was shown that the time of fall T_1 was equal to $\frac{U}{g}$. Therefore, the time of rise must equal the whole time of flight T minus the time of fall T_1, or

$$T - T_1 = \left(\frac{2U}{g} - \frac{U}{g}\right) = \frac{U}{g}$$

which is the same as the time of fall. Likewise the velocity at the end of the fall will be given by the equation $U = gT_1$, which is the same as the initial velocity of the body. Hence *a body projected vertically upward will require the same time to fall as it did to rise; and will reach the ground with the same velocity as that with which it was projected upward.*

The equations for falling bodies may then be summarized as follows:

$$V = gT_1 \quad (41)$$

$$H = \tfrac{1}{2} gT_1^2 \quad (42)$$

$$V^2 = 2gH \quad (43)$$

$$T_1 = \frac{U}{g} \quad (44)$$

where T_1 is the time of rise or fall in seconds; H is the vertical distance (in feet) the body has fallen; V is the velocity at the end of the fall, expressed in feet per second; and U is the velocity in feet per second with which the body was projected upward.

Laws of Motion

Thus far the motion of a body has been discussed without any reference being made to the forces producing the motion. For a clear understanding of the three laws of motion, as stated by Sir Isaac Newton, it will be necessary to define certain terms which are involved in these laws.

The *mass* of a body is the amount of material in the body. A cubic foot of iron and a cubic foot of wood occupy the same space, but experience teaches that the iron requires more force to put in in motion than does the wood, or if equal forces are applied to the two bodies the iron will move with a less acceleration than the wood.

The property of matter whereby force is required to change the state of rest or uniform motion of a body is called the *inertia* of the body. This property of matter accounts for the fact that it requires much more force to start, or put a body in motion than it does to keep the body moving at a uniform rate. A fireman in the boiler room finds it much harder to start a coal truck in motion than he does to keep it moving across the boiler-room floor.

The *density* of a body is the mass of a unit volume of

the body. The British unit of mass is called the Imperial pound, and consists of a lump of platinum deposited in the Exchequer office.

Let

M = The mass of the body;

V = The volume;

and

d = The density;

then,

$$M = V \times d \qquad (45)$$

or the mass of a body is equal to its density times its volume. The density of a body depends upon the relative closeness of the molecules of the body.

Momentum is the amount of motion in a body and is measured by the product of the mass times the velocity of the body. As defined in an earlier lesson, force is that which changes or tends to change the state of rest or motion of a body. Hence the true measure of a force is the amount of motion destroyed or generated by the force in a given unit of time. Let m = the momentum of a body and V its velocity, then by definition,

$$m = M \times V \qquad (46)$$

Law I.—Every body continues in its state of rest or of uniform motion in a straight line, except in so far as it is compelled by imposed forces to change that state.

This law is proved by common observation. Thus the piston of an engine would continue in motion if it were not for external forces which are brought to bear upon it. A bullet shot from a gun would move in a straight line with a constant velocity if it were not for gravity exerting a downward pull upon it and the air offering a resistance to the motion of the bullet. This law shows the effect of the inertia of a body, for, to change the motion of a body, its inertia must be overcome and this can be done only by the application of forces external to the body itself.

Law II—Change of motion is proportional to the impressed force and takes place in the line of action of the force.

As previously stated, the momentum is the quantity of motion in a body and therefore any force which produces a change of motion must be proportional to the momentum of the body. If the mass remains constant, the change in momentum will be dependent upon the change in velocity which, by definition, is the acceleration.

Let

F = The effective force producing motion;

M = The mass of the body;

and

a = The acceleration.

Then the effective moving force (F) will equal the product of the mass (M) times the acceleration (a) if the unit of force is taken as that force which will give to a unit mass in one second an acceleration of one foot per second per second. This unit of force is called the *poundal*. Hence,

$$F = M \times a \qquad (47)$$

The poundal is called the absolute unit of force because its value is not dependent upon the force of gravity, which changes with the location of a body relative to the center of the earth.

The *weight* of a mass of one pound is the force with which gravity draws the given mass toward the earth; hence, from equation (47), the weight of one pound is equivalent to 32.16 poundals of force, since gravity produces an acceleration of 32.16 ft. per sec. per sec., or expressed as an equation,

$$W = M \times g \qquad (48)$$

If the unit of force be taken as the weight of one pound, it will equal 32.16 poundals, or the poundal is equal to about ½ oz. avoirdupois. It is well to note that while the mass of a body remains constant, the weight of the body will vary depending upon the location of the body, for it has been shown that the value of g varies. When the weight of one pound is used as the unit of force, it is called the *gravitation unit of force*, since its value depends upon the value of g.

Therefore in equation (47) the forces F may be expressed in pounds instead of poundals, if the value of M as given by equation (48) be substituted, thus,

$$F = \frac{W}{g} a \qquad (49)$$

where

F = The effective moving force in pounds;

W = The whole mass moved in pounds;

and

a = The acceleration in feet per second per second.

Law III—To every action there is an opposite and equal reaction. This law was discussed under Lesson I, to which the student is referred.

Study Questions

86. Due to the force of an explosion, a piece of boiler plate was projected vertically upward with a velocity of 100 ft. per sec. How far was the plate from the ground at the end of the second second?

87. What is the density of water; of coal? Explain the difference between density and specific gravity.

88. What force in poundals will produce an acceleration of 4 ft. per sec. per sec. on a mass of 100 lb. (neglect friction)?

89. An electric crane raises a flywheel weighing 10 tons with an acceleration of 1¼ ft. per sec. per sec. What is the tension in the hoisting cable?

90. If the wheel is brought to rest with a retardation of 2 ft. per sec. per sec., find the tension in the cable while the wheel is coming to rest.

Vasil Shaking and Dumping Grate

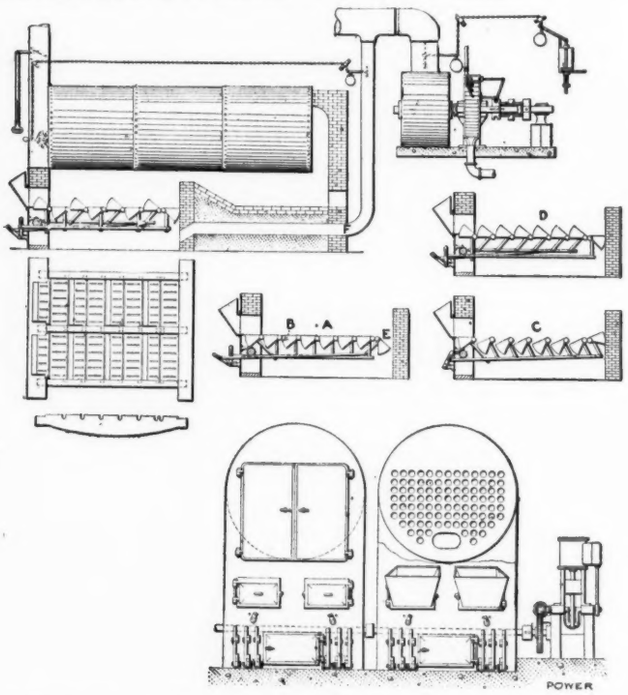
A combination shaking and dumping grate, designed for burning fuel either mechanically fed or hand fired, is illustrated herewith. The grate surface is made up of one, two or more sections reaching across the width of the furnace. Each section is independent of the other, but all work in unison when the stoker is in operation.

The sections are secured to a shaft which oscillates in side-bearing beams; the tops are flat, so that when the grates are as shown at A, the total grate area presents an even surface. The sections are fan-shaped, with the inside end so curved as to bring the end B close to the small end of the next section, no matter what the position of the section except when dumping, as shown at C. At D, the grate is shown with the sections at their extreme forward position.

Movement of this grate, which is made by the Vasil Fuel & Steam System Co., 140 Broadway, New York

City, is obtained from a shaft running across the front end of the furnace under the dead plate; this shaft is fitted with clutch gears made with a blank section. Each gear engages with a short rack, which operates a carrier arm connecting with an arm extending down from each grate section. As the gear revolves in the direction of the bridge-wall, the rack is moved toward the front of the furnace, which rotates the grate to the position shown at *D*, until the blank section comes opposite the rack, when the grates will fall back to a level position *A*. This movement breaks up the fuel and at the same time moves it toward the rear end of the furnace. When desired, the clutch gears can be thrown out of mesh with the rack, and the grates operated by hand to increase the stoking action or to dump the ash and clinkers into the ashpit by manipulating levers on the front of the furnace.

At the rear end of the grates is a dumping plate *E*, which remains stationary while the stoker is in operation; it is operated by a hand lever from the front of the furnace when it is desired to dump the ashes.



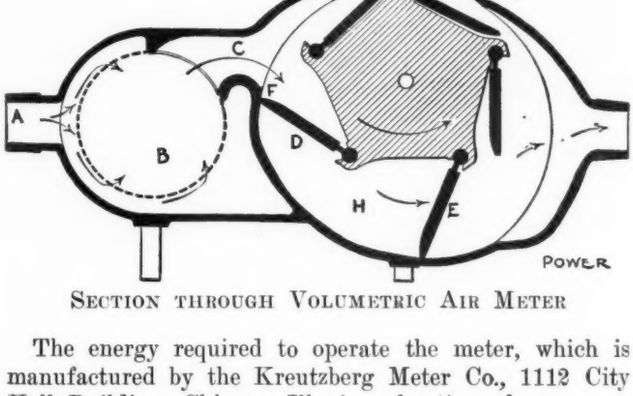
DETAILS OF VASIL SHAKING AND DUMPING GRATE

Fuel is deposited in the hopper, which is attached to the furnace door and can be swung out of the way to permit of hand firing if necessary, and for working the fires. Forced draft is supplied by a turbine blower through an air duct *F*, which discharges into the ashpit. The turbine is under the control of a damper regulator; there is also a hand control for the uptake damper.

Kreutzberg Volumetric Air Meter

This device measures the air used in pneumatic tools. Referring to the illustration, the inlet *A* admits air to the screen chamber *B*. The air then passes into the meter through the passage *C* and, impinging against the vane *D*, causes the drum to revolve. As the vane *D* passes the point of cutoff at *F*, a fixed volume of air is contained between the vanes *D* and *E*. As soon as *E* reaches the outlet the pressure in the pocket *H* is discharged into the pipe line. The meter is sealed at the top by the shoe *M*.

The meter is calibrated to the volumetric displacement, and for noncompressible fluids the readings are taken from the register itself. In gaseous fluids the volume of the atmospheric pressure is directly proportional to the pressure in the atmospheres at which the fluid is measured.



SECTION THROUGH VOLUMETRIC AIR METER

The energy required to operate the meter, which is manufactured by the Kreutzberg Meter Co., 1112 City Hall Building, Chicago, Ill., is a fraction of an ounce, and the pressure on both sides of the vanes differ only by the amount of pressure required to operate the meter.

As the meter is made of bronze, corrosion is eliminated. It is adapted to measure steam and gas as well as air.

Armstrong Steam Trap

A departure from the usual designs of steam trap is the inverted submerged-bucket type made by the Armstrong Machine Works, Three Rivers, Mich.

As shown in the sectional view, the inlet is at the center of the bottom, immediately underneath an inverted bucket. Normally, the weight of the bucket causes it to rest on the bottom of the trap, holding the valve wide open. Small feet on the bucket raise it so that condensation can flow underneath into the trap body. The water fills the body and the bucket, the air in the latter escaping through a small vent into the top of the trap body and out through the outlet provided. The trap is therefore filled with water, and as long as it continues to enter, the bucket will remain on the bottom and hold the discharge valve open.

SECTIONAL VIEW OF STEAM TRAP

When steam enters the trap, it rises to the top of the bucket, displacing the water and increasing the buoyancy until the bucket rises and, through the system of levers shown, closes the valve. A little steam will naturally pass through the air vent, but as the pressure forcing it through is only 1 to 3 oz. per sq.in., the quantity will be so small that it will be readily condensed and there will be no accumulation in the top of the trap. The full travel of the bucket is about 1 in. Due to the powerful system of levers, the outlet valve can be large and the capacity of the trap great for its size.

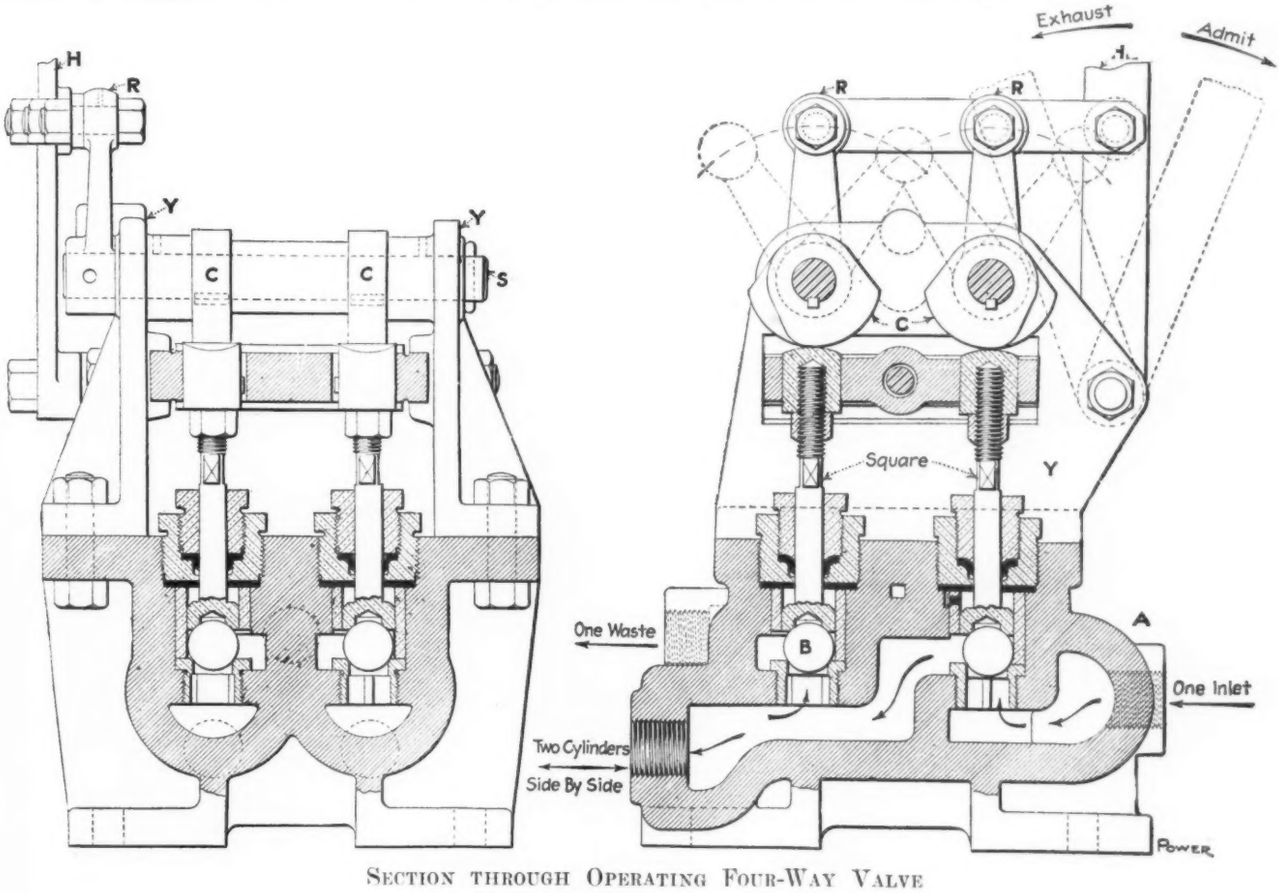
One of the strong points claimed for it is that air binding cannot occur. The valve diameter is varied from $\frac{1}{8}$ to $\frac{5}{16}$ in., with capacities ranging from 230 lb. per hr. for the smallest size and 1 lb. pressure to 15,600 lb. for the largest valve and 200 lb. pressure.

Schnicke Operating Four-Way Valve

For operating hydraulic machinery in steel mills and manufacturing plants there has been placed on the market the Schnicke hydraulic operating valve. It has a horizontal valve chamber *A*, which is provided with pressure and waste ports, stuffing-boxes, bushing and seat rings. A yoke *Y* is bolted to the top of the valve chamber and forms the bearings for the end of the camshafts *S*. The cams *C* and rocker-arms *R* are keyed to the shafts, which are rotated by connecting the upper ends of the rocker-arms to the hand lever *H*.

As shown in the illustration of a four-way valve, seat rings are screwed into the pressure and waste ports of the valve chamber. Between the seat and the stem a hard bronze ball *B* is employed, which changes its position at each operation of the cam. The upper end of the stem is threaded into a bearing, which travels through a web in the yoke castings; the lower part of the stem is held in position by the stuffing-box, gland and bushing. The cams are oppositely mounted on the shafts and are so arranged that when moving the hand lever in one direction the pressure port is closed before the waste port opens, and *vice versa*.

By applying power to the hand lever, the upper ends of the rocker-arms are forced in one direction or the other, thereby rotating the shafts on which the cams are mounted. When the lever is thrown in the direction to allow the pressure valve to open, the fluid pressure raises the ball from its seat and passes to the machine. While the pressure port is open, the waste port remains closed until the pressure on the machine is to be released. By moving the lever in the opposite direction, the pressure port is closed and the waste port allowed to open, thereby releasing the pressure on the machine. As each stem has a square and threaded end, the operator can adjust either valve from the outside without shutting off the line pressure or the connecting valve.



SECTION THROUGH OPERATING FOUR-WAY VALVE

The outside adjustment feature enables the operator, from time to time, to take up the wear on the seats, thereby preventing leakage and maintaining the pressure in the line.

This valve is manufactured by the Schutte & Koerting Co., Twelfth and Thompson Sts., Philadelphia, which is also putting out a three-way valve of similar design.

A Glossary of Public-Utility Terms Compiled from Various Sources

By L. R. W. Allison

With the increasing growth of public-utility enterprises and the jurisdiction exercised over various classes of such properties by state and city commissions, there have come into everyday engineering practice words and terms that have an important bearing in the engineer's work. A correct knowledge of the meaning of such recognized terms is a fundamental feature of engineering education, whether one is connected with a central station or an isolated plant.

These terms are a part of engineering literature, and passing them by is neglecting an opportunity for that broader knowledge which leads to advancement. The progressive engineer should and must know their meaning and significance; he must know how and when to apply them in his daily contact and dealings, and when called upon to express opinions at board meetings and the like, he must know the correct way to employ them.

Public-utility terms, in the broader sense, deal not only with operation but with construction, financial, accounting and cost factors, all of which interlock as a part of the engineer's province. The accompanying glossary summarizes such terms in current use, and is a concise reference work.

ACCESSORY ELECTRIC EQUIPMENT: Busbars, station cables, regulators, station switchboards and such apparatus as ammeters, voltmeters, wattmeters, switches, circuit breakers, with foundations and settings, and station terminal board, special high-tension transmission equipment; pump and air-compressor motors, and headgate motors.

ACCESSORY GAS WORKS EQUIPMENT: Exhausters, station meters, governors; retort charging apparatus; tar and ammonia apparatus, pumps, pipes, tanks and conveying equipment for the disposal of coke and other products.

ACCRUED AMORTIZATION OF CAPITAL: Depreciation of value of plant and equipment; any other amortization of fixed capital.

AMORTIZATION: Gradual extinction of a charge or charges; clearing off expiring value. Applied to both tangible and intangible property in a comprehensive sense of depreciation in value.

APPROPRIATION ACCOUNTS: A group of accounts which show for any fiscal period the changes in the corporate surplus of a company. Such accounts are usually closed into a general corporate surplus or deficit account at the close of a respective period.

CAPITAL: All property devoted to the production of a company's commodities, and the rendering of service in connection therewith.

CAPITAL, DEPARTMENTAL: A division of fixed capital, being all capital given over solely or primarily to a single and particular class of operations.

CAPITAL, FIXED: Such capital as has a life or expectation of life in service of periods of more than one year.

CAPITAL, FLOATING: A term given to all capital other than fixed capital.

CAPITAL, GENERAL: A division of fixed capital, being such capital as is available for the uses of any two or more classes of operations.

CAPITAL, INTANGIBLE: A division of non-landed capital, being that capital which comprises organization, patent-rights, franchises, etc.

CAPITAL, LANDED: A division of fixed capital, being that which comprises all interests in land for terms of more than one year. Any improvements to the land are usually excluded.

CAPITAL, NONLANDED: A term given to all fixed capital other than landed.

CAPITAL, TANGIBLE: A division of nonlanded capital, being that which comprises structures and equipment having a life or expectation of life in service of periods of more than one year.

CONSUMER DEPOSITS: All cash deposited with a company by consumers as security for the payment of electric, gas or water bills.

CONTROLLED CORPORATIONS: Public utility companies which are controlled through financial interest by another public utility or holding company.

COÖRDINATE DEPARTMENTS: Allied interests of a company which are devoted to subsidiary operations from its main source of revenue. Such as an electric railway company which engages in rendering service in electric light, power, gas, etc.

COST: When used in connection with operating expenses, being the cash or money cost, and distinct from prices based on a term of credit.

DEBENTURE: Any portion of funded debt which is supported only on the general credit of a company, and is not secured by lien, mortgage or otherwise; such as an unsecured promissory note, etc.

DEBT: Absolute obligations to pay money at a specific time or times, or at periods subject to definite demand of a creditor. Contingent obligations, as rent, etc., are usually excluded.

DEBT, FUNDED: All debt of a nature which does not mature until more than one year from the time of its inception.

DEBT, UNFUNDED: All debt of a nature which matures within one year or less from the time of its inception.

DEPOSITS, SPECIAL: Money and bank credits in the hands of agents or other representatives of a company to defray payments of coupons, dividends, or other special purposes. Funds available for general purposes, such as credits at banks subject to check, etc., are excluded.

DISTRIBUTION SYSTEM (ELECTRIC): Overhead or underground distribution system, or both, including distribution main conductors and feeders; all wires, cables, insulators and insulating material and apparatus.

DISTRIBUTION MAINS AND ACCESSORIES (WATER): All land and right-of-way of pipe lines for distribution of water to customers; special castings, gate valves and boxes, regulating valves, air chambers, blow-off cocks, flush plugs and other special equipment.

ELECTRIC OPERATIONS: Operation of a plant for the production of electric energy, transmission of such, and the distribution to consumers for light, heat or power service, and all incidental operations thereto.

GAS OPERATIONS: Operation of a plant for the production of gas, natural or manufactured, transmission of such, and the distribution to consumers for light, heat or power service, and all incidental operations thereto.

GENERAL AMORTIZATION: Accrued obsolescence, wear, tear and depreciation in the respective period in the tangible capital of a company; such portion of the life of the intangible fixed capital as has been consumed or may have expired in the respective period; and any loss of property through extraordinary casualties in the computed period.

GENERAL EQUIPMENT: When used in distinction from general utility operations, infers general shop equipment, general store equipment, general office equipment, and general stable equipment.

GENERAL STRUCTURES: When used in distinction from general utility operations, infers all buildings and other structures of a permanent character used for general purposes, such as office buildings, shops, storehouses, etc., and all fixtures permanently installed.

GOING CONCERN: A term applied to a company when it becomes actively engaged in its particular utility operations, following its preliminary work incidental to such operations.

GOING-CONCERN VALUE: The value which a property possesses, inclusive of its business organization, management and profitable operation, such value being above its physical and other intangible values.

INCOME DEDUCTIONS: Deductions to which a company's gross income is usually subject; these are usually compulsory and for the most part contractural, such as interest accrued on funded debt, sinking fund accruals, rent deductions, etc.

INDICANT ACCOUNTS: A group of accounts comprising asset, liability and fixed capital accounts; also known as the "Balance Sheet."

INVESTMENTS, BOUND: Investments which are subject to a lien or claim of some character.

INVESTMENTS, FREE: Investments which are free of all liens or claims.

JOINT ELECTRIC RENT REVENUE: The profit derived by a company, over and above any allowance for wear, tear and depreciation, in operating a plant for the production of power for the benefit of another company or companies, under an arragement for the division of expenses.

JOINT FACILITY RENTS: The operation of a plant, or any equipment, for the benefit of two or more companies under a joint arrangement for the apportionment of expenses on a basis of the relative amount of respective benefit.

LABOR: When used in connection with operating expenses, being distinctly human services of whatever character.

MESNE ASSIGNMENT: The assigning of property, particularly of the nature of a franchise, by a company to others during the life of the period for which such privilege has been granted.

MISCELLANEOUS POWER PLANT EQUIPMENT: Apparatus intermediary between prime movers and electric generators; mechanical equipment such as pulleys, belts, hangers, countershafts; machine tools, hoists, cranes, etc.

NONOPERATING REVENUES: Revenues derived from property or interests in property by a company when such property is not used directly for operations, but is in the hands of others, such as rents, leaseholds, etc.

OBSOLESCENCE: Equipment and apparatus becoming obsolete and falling into disuse.

OPERATING EXPENSES: Expenses necessary to the maintenance of a company, the production and distribution of its commodities, the rendering of proper service in connection therewith, and the collection of revenues derived from such service.

OPERATING REVENUES: All amounts of money which the company receives or is lawfully entitled to for the distribution of its commodity and services rendered in connection to its consumers; and all returns upon property used by the company in its own operations.

PERIODIC PAYMENTS: Payments guaranteed by a company at a specific time or times to defray an obligation.

PREMIUM REALIZED: The excess of actual money value realized upon any particular stock at the time of issue over the par value of the stock.

PREPAYMENTS: Payments for such items as taxes, rents, insurance, etc., made in advance of the specific period to which they pertain.

PRODUCTION EXPENSES (ELECTRIC): Station wages, fuel, supplies, and repairs to station buildings, steam, electric and hydraulic equipment.

PUBLIC UTILITY: Every individual, association, copartnership, corporation or joint stock company that owns, operates, manages or controls any electric light, heat, power, water, gas, oil, sewer, telephone or telegraph, plant or equipment for rendering public service; also any steam railroad, street railway, traction railway, canal, express, subway or pipe line.

PURIFICATION SYSTEM (WATER WORKS): All land, structures and equipment employed in connection with the purification of water, and in conveying water from one part of the purification system to another; and power plant and pumping equipment used for the delivery of wash water for filter or sand washing.

REACQUIRED SECURITIES: Securities that have been issued to bona fide holders for value, and later reacquired by a company; such securities are usually either stocks or funded debt.

RESERVES, CONTRACTUAL: Such reserves as are necessitated by contracts of a company, such as reserves to cover sinking funds as stipulated in mortgages, etc.

RESERVES, NONCONTRACTUAL: Temporary reserves as are raised without being required by any contract or agreement.

RESERVES, OPTIONAL: A division of noncontractual reserves, being those created solely at the discretion of a company.

RESERVES, PERMANENT: Reserves that must be maintained intact during the life of a company, such as premiums on stocks, etc.

RESERVES, TEMPORARY: Reserves not intended to be held intact during the life of a company.

SINKING FUNDS: Funds maintained for the purpose of redeeming outstanding obligations.

STOCKS: Securities which represent permanent interests in the company, such interests which, if terminable, are only so at the option of such company.

STOCKS, DEBENTURE: Stocks issued under a contract guaranteeing payment thereon of a specified return at specific periods.

STOCKS, COMMON: Stocks whose claims in the distribution of dividends are subordinate to those of all other stocks.

STOCKS, FIRST PREFERRED: Stocks whose claims in the distribution of dividends are foremost above those of all other stocks.

STOCKS, SECOND PREFERRED: Stocks whose claim in the distribution of dividends are next after those of first preferred stocks.

SUSPENSE: Used in connection with a system of accounts, being any expenditure made in which the exact disposition is not immediately determinable; the occurrence of any loss spread over a period of time; and when any debit is amortized through charges made to expense or other income accounts over a period of time.

TRANSMISSION SYSTEM (ELECTRIC): Under usual conditions, the outside lines and conductor system to the point of step-down transformers or motor-generator sets, etc., including wires, cables, insulators and insulating materials and apparatus.

TRANSMISSION MAINS AND ACCESSORIES (WATER): Used only in connection with water works operating pumping stations, being all land and right-of-way of main pipe lines which convey water for long distances without any connections for service, from the pumping station to the distributing storage reservoir or distributing system mains; with special castings, valves, valve vaults, boxes, etc.

UNAMORTIZED DEBT DISCOUNT AND EXPENSE: The excess of the sum of the par value and accrued interest over the cash value of the consideration received from the sale of funded debt securities and other evidences of indebtedness, when such are disposed of for a sum less than the par value.

UNAMORTIZED PREMIUM ON DEBT: The excess of the sum of the cash value received over the par value and accrued interest from the sale of funded debt securities and other evidences of indebtedness, when such are disposed of for a sum greater than the par value.

WATER COLLECTING SYSTEM: Structures and equipment used in the collection of water, and its conveyance from the point of collection to the purification or pumping plant. Or in the case of a gravity system, to a point from which it is distributed to consumers.

Industrial Education and the Engineer

By E. H. FISH

Massachusetts has now some nine schools for the industrial education of boys, in three or four of which experiments are being tried in training engineers. The state law contemplates the admission of pupils at any time after they are 14 years old. The average age at admission, however, is at least 15, but even then a two-year course, as given at some schools, would make the graduates only 17 and the four-year courses in other schools, 19 years old, both considerably below the age of sufficient maturity for responsible work around engines and boilers. This is not altogether a misfortune, for the intervening years may be profitably spent in subordinate positions where, even if the pay is small, the experience is good.

These schools do the best they can in giving the pupils a taste of the real life of a fireman and engineer, but of necessity their service plants are small and their experimental plants are smaller. In Worcester there are two vertical fire-tube boilers each of 100 hp. The service engine is a Westinghouse compound of 75 hp. There is a spare engine used for service during the lighting season and for experiment the rest of the year. This is a high-speed, inertia governor engine of 90 hp. These two machines are connected to 55-kw. generators, one of them a three-phase 220-volt machine, the other a direct-current generator of the same voltage which is used to supply light when the first generator is overloaded. There are four other smaller slide-valve engines, one with a riding cut-off and centrifugal flywheel governor, the others with throttling governors. There is also nearly complete a small Corliss engine on which the pupils in the machine shop have been working as opportunity offered for the past year and a half. This is as comprehensive an equipment as such a school can reasonably be expected to furnish unless a much greater demand for such training should come than has at present appeared. The New Bedford school has a 50-hp. pro-

ducer-gas plant and engine which it uses for a service plant, but the others for the most part have even more meager equipment. Smaller apparatus, pumps, injectors, valves, gages, etc., are easily obtainable from the makers so that there is no difficulty about adequately presenting that subject.

All of the schools have good opportunities for steamfitting work in connection with their own plants. The same is true of electric wiring. In Worcester, the pupils have done all the steamfitting, not merely for the experimental engines, but for the heating, by vacuum system, of the recent addition of nearly an acre of floor space. They have also put in the lighting system, including the switchboards, which they have built, and the installation of half a dozen motors. In fact, these are the easiest things to handle in connection with such a course; the most difficult is that connected with what may be called purely service work. Only two boys can be kept busy at once in the service plant actually firing and looking after the engine—more would be in each other's way. Furthermore, they would have a tendency to fool that would be bad for them and for the school, for if there is any place where strict attention to business is essential it is in the engine room. Three or four boys can be kept busy around each engine to advantage so long as it is used for experiment. They can learn to set valves, to adjust and scrape bearings, to locate knocks, take indicator diagrams, etc., but they get but little idea of looking far enough ahead to keep the engine running under all conditions; these they must get in the service plant of the school, or else in some plant outside.

The electrical work, however, is the thing that draws the largest number of boys. They often come with the idea that that is all there is to an engineer's duties that makes them worth doing. Except for the fact that it is impossible to give them experience with really heavy generators and high voltages, this is the easiest thing to handle of all. Wire can be used over and over again, lights and motors can be installed for the use of other departments, and if that work should run low there is plenty of chance to relocate both motors and lights.

After all, the greatest opportunity for the pupils, considered in the light of the usual lack of opportunity, is in the class-room work of a technical nature. The work of an engineer involves considerable technical work, which is not given in its practical aspect in engineering schools. Work of this nature must be given from a simple and practical viewpoint in a trade school or the pupils will not grasp it at all, in which case they will not stay at school. In this work the assistance of textbooks is almost worthless. It must be taught from handbooks, trade catalogs and technical papers. Textbooks attack all these subjects in ways which involve mathematics much beyond the capacity of the pupils of trade schools, and they approach their subjects in the exactly opposite way from that in which the various laws of nature were discovered. That is, they assume that the laws have been correctly interpreted, and then from these laws they proceed to deduce facts which agree fairly well with what is found in practice, instead of beginning with what is found in practice to be true and then from that showing how these laws may be interpreted. It is unfortunate that textbooks which handle things in this latter way are not available, but, on the other hand, it is fortunate that the present condition does not make it possible for men to "fake" teaching, as is possible in colleges.

New England States Convention

The New England States Association of the National Association of Stationary Engineers held its annual convention at Providence, R. I., July 8, 9, 10 and 11, with headquarters at the Crown Hotel.

The meetings of the delegates were held in the assembly rooms of Infantry Hall, and in the large drill room across the hall was the exhibition of power-plant machinery, accessories and supplies, under the auspices of the New England Association of Commercial Engineers. The display on this occasion was the largest yet held and was well attended.

In the exhibition hall at eleven o'clock on Wednesday morning, Major James W. H. Myrick called the assembly to order and introduced Mayor Joseph H. Gainer, who spoke briefly and interestingly of Providence, and welcomed the convention to it.

He was fittingly responded to by Bradford L. Ames, president of the New England Association of Commercial Engineers.

John P. Farnsworth, president of the Chamber of Commerce, was then introduced and talked pleasingly of the early days of engineering and told of the wonderful advancement and of the high standard that was required of the operating engineer of the present day.

W. C. Barnes, vice-president of the association, then addressed the meeting, after which the exhibition was formally opened by Major Myrick.

On Friday morning at eleven o'clock the delegates and guests assembled in Infantry Hall for the preliminary exercises of the convention. Riley Daniels, the presiding officer, introduced Aram J. Pothier, governor of Rhode Island, who said how pleased he was to have the convention come to his state, and hoped that the stay in Providence would be both profitable and enjoyable. Asa M. Day, Mayor Gainer, Thomas A. Ray, National President James R. Coe, Mayor G. W. Easterbrooks, of Pawtucket; Mayor Walter F. Snow, of Central Falls; Mayor John W. Horton, of Cranston, and J. T. Maloney, past-president of the Commercial Engineers, also made addresses. The meeting then went into executive session and President Asa M. Day appointed the several committees, after which the meeting adjourned until the afternoon session.

DELEGATES AND GUESTS AT THE NEW ENGLAND STATES

A smoker was held on Friday evening in the banquet hall of the exhibition building under the auspices of the Commercial Engineers. Good things to smoke were distributed, and an enjoyable entertainment was given by Bert Self, Peerless Rubber Manufacturing Co.; Billy Murray and Joe McKenna, Jenkins Bros.; Michael O'Connell, New Jersey Mechanical Rubber Co.; Jack Armour, "Power"; Michael Foran, Bob Jones, Monroe Silver, and Jim Devins. The big number of the night occurred when Master of Ceremonies Frank Martin called F. R. Low and Bradford L. Ames to the stage. Mr. Low, in a few well chosen words, presented a solitaire diamond scarf pin to the past-president of the Commercial Engineers, the gift of his friends among the supplymen.

On Saturday morning at 8 o'clock there was an automobile ride for the delegates through the park system of Providence.

At ten o'clock on Saturday morning the convention enjoyed a steamboat trip to Potter's Cove Club, where a genuine

Rhode Island clambake was served. Before the bake there was a baseball match between the Engineers and the New York "Bunch," which resulted in a victory for the Engineers by the score of 7 to 2.

At the meeting of the delegates on Friday the officers for the ensuing year were elected as follows: Asa M. Day, past-president, New Haven, Conn.; Thomas A. Ray, president, Cambridge, Mass.; Riley Daniels, vice-president, Pawtucket, R. I.; John F. Quinn, secretary, Holyoke, Mass.; Walter Damon, treasurer, Springfield, Mass.; M. M. Childs, conductor, Providence, R. I.; Timothy Horan, doorkeeper, Ludlow, Vt. National President James R. Coe installed the officers and pinned a past-president's jewel on Asa M. Day.

At the meeting of the Commercial Engineers on Friday afternoon, Herbert E. Stone, treasurer, was presented a handsome combination silver cake dish and cut-glass bouquet holder, William K. Campbell making the presentation speech. The election of officers resulted as follows: William K. Campbell, president; James W. H. Myrick, vice-president; Herbert E. Stone, treasurer. Bradford L. Ames, W. Carleton Barnes and Fremont Eggleston, Jr., were chosen for directors for three years, and Brooks Faxon for one year.

Holyoke, Mass., was selected as the convention city for 1915.

EXHIBITORS

Acme Electric Co.
Albany Lubricating Co.
Allen Manufacturing Co., Inc.
American Graphite Feeding Device Co.
American Oil Co.
American Steam Gauge & Valve Manufacturing Co.
Jenkins Bros.
Jefferson Union Co.
Keystone Lubricating Co.
H. W. Johns-Manville Co.
Lunkenheimer Co.
Manning, Maxwell & Moore
Mason Regulator Co.
Massachusetts Fan Co.

Court Overrules Public-Service Commission

A most important decision has been rendered by the Appellate Division of the Supreme Court of New York in the case of C. Perceval vs. the New York Edison Co.

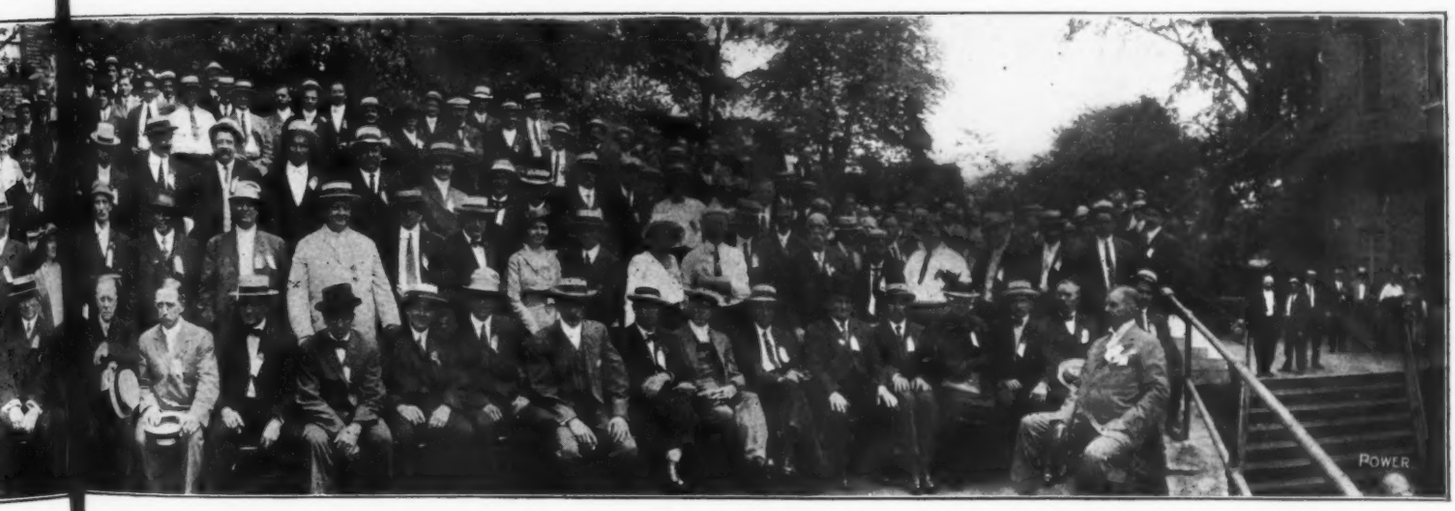
The case dates back just about a year at which time the complainant, C. Perceval, had in course of construction at Nos. 2-6 Ninth Ave. a building on leased ground and made application to the New York Edison Co. for service connection, refusing, however, to subscribe to the clause in the contract that no other electric service should be used or introduced in connection with the equipment supplied without the written consent of the Edison Co.

In the adjoining building occupied by Frank I. Wing, there was a private plant, which it was arranged should supply the new building from 7 a.m. to 5:30 p.m., the street service to be used only during the night.

The New York Edison Co. refused to sell electricity under these conditions and Mr. Perceval appealed to the Public Service Commission to compel the company to do so.

After a number of hearings the commission reached the decision on Mar. 3, 1914, sustaining the New York Edison Co., holding that a public service corporation may not reasonably be required to furnish breakdown service for a competitor furnishing the same kind of service in the same area.

The case was then taken to the courts and the decision, which reverses that of the Public Service Commission, holds that in consideration of the privileged position of the company, especially in its use of the streets, it must serve impartially every member of the community who demands service. It may establish reasonable regulations, but the requirement that a consumer must take all his energy from one company or receive none is declared an arbitrary attempt on the part of the company to insure to itself a monopoly of furnishing energy.



CONVENTION, PROVIDENCE, R. I., JULY 8-11, 1914

V. D. Anderson Co.
Ashton Valve Co.
Atwood & Morrill
Autoforce Ventilating System
J. Henry Blanchard
Bowers Rubber Works
Brown Bros. Co.
Bryan-Marsh Division National Lamp Works of General Electric Co.
Buhne Metal Packing Co.
Burke Engineering Co.
Builders Iron Foundry
Chapman Valve Manufacturing Co.
A. W. Chesterton Co.
C. A. Claflin Co.
Clement Restein Co.
Climax Smoke Preventer Co.
Crandall Packing Co.
E. M. Dart Manufacturing Co.
M. T. Davidson Co.
Dearborn Chemical Co.
Diamond Power Specialty Co.
Durabla Manufacturing Co.
Eagle Oil & Supply Co.
Gardner Grate Co.
Garlock Packing Co.
General Fire Extinguisher Co.
Greene, Tweed & Co.
A. W. Harris Oil Co.
Wm. A. Harris Steam Engine Co.
Hart-Edison Packing Co.
Hart Packing Co.
Hills-McCanna Co.
Home Rubber Co.
Chas. J. Jagar Co.
Geo. P. Dixon Co.
Griscom-Russell Co.
McLeod & Henry Co.
Narragansett Electric Lighting Co.
"National Engineer"
New York Revolving Portable Elevator Co.
Open Coil Heater & Purifier Co.
Patterson Lubricating Co.
Pennsylvania Flexible Metallic Tubing Co.
Perino Chemical Works
Perolin Co. of America
Peerless Rubber Manufacturing Co.
Philadelphia Grease Manufacturing Co.
"Power"
Providence Engineering Works
Publicity Committee, R. I., N. A. S. E.
Quaker City Rubber Co.
Revere Rubber Co.
Rhode Island Covering Co.
Rhode Island Welding & Sherardizing Co.
Rhode Island Supply & Engineering Co.
Walter G. Ruggles Co.
Spencer Turbine Cleaner Co.
Syracuse Faucet & Valve Co.
Tillotson Humidifier Co.
Thomas Evans
Vanda Co.
Vasil Fuel & Steam Systems Co.
Wholey Boiler Works
Wiener Machinery Co.
E. De F. Wilkinson Co.
Wm. R. Winn

BOOKS RECEIVED

MATHEMATICS FOR THE PRACTICAL ENGINEER. By Charles H. Bromley and Henry R. Cobleigh. McGraw-Hill Book Co., New York. Cloth; 220 pages, 5¼x8¼ in.; 75 illustrations; tables. Price, $2.

FUEL ECONOMY AND CO_2 RECORDERS. By A. R. Maujer and C. H. Bromley. McGraw-Hill Book Co., New York. Cloth; 189 pages 5¼x8¼ in.; 28 illustrations. Price, $1.50.

METHODS OF MACHINE-SHOP WORK. By F. A. Halsey. McGraw-Hill Book Co., New York. Cloth; 286 pages, 5¾x9¼ in.; 285 illustrations. Price, $2.50.

Effect of Soot on Vegetation—This is the subject dealt with in Bulletin 7, the latest put out by the Mellon Institute of Industrial Research. The bulletin was written by J. F. Clevenger, botanist for the smoke investigation committee, and the investigation was undertaken by the botanical department of the Pennsylvania State College coöperating with the Mellon Institute. Observations have been made in public parks in Pittsburgh, Chicago and the vicinity, and along railroad lines and in mill districts. The conclusions of other investigators here and abroad are given.

American Boiler Manufacturers' Coming Convention

The American Boiler Manufacturers' Association will hold its 26th annual convention in New York City, Sept. 1 to 4, with headquarters at the Waldorf-Astoria Hotel. All boiler, tank and stack manufacturers, and fabricators of steel plate, also manufacturers and representatives of materials and supplies used by boiler manufacturers, are invited to attend.

A number of interesting papers on subjects of importance to boiler and plate manufacturers will be read. Uniform boiler specifications will be thoroughly discussed, and it is hoped that some action on this subject will be taken at this convention.

If those anticipating attending will send their names to F. B. Slocum, secretary, West and Calyer Sts., Brooklyn, N. Y., or to any of the following members of the publicity committee, arrangements for locating them during the convention will be made:

Publicity committee—H. R. Cobleigh, chairman (managing editor "Power"), Tenth Ave. and 36th St.; George H. Partridge, Sweet's Catalogue Service, Inc., 119 West 40th St.; J. M. Lloyd, "The Iron Age," 239 West 39th St.; Watson S. Anthony, manager, "Industrial Engineering," 120 West 32d St., and George Slate, "The Boilermaker," 17 Battery Place, all of New York City.

Licensing of Stationary Engineers—An ordinance such as was adopted in Buffalo, prohibiting the granting of a license to a stationary engineer, unless he has been a resident of the city for three years, is unconstitutional as an unreasonable interference with the right to engage in a lawful business, guaranteed by the United States Constitution, according to the decision of the United States District Court for the Western District of New York in the case of Williams vs. McCartan, 212 "Federal Reporter," 345. The court said in this case:

The state legislature no doubt had the power to authorize the municipality to enact an ordinance requiring applicants for licenses to run stationary engines within the city of Buffalo to submit to an examination as to their qualifications, and to give them, if qualified, a stationary engineer's license of the same relative grade as the United States license held by them, as specified in the charter; but the legislature cannot restrict the issuance of such licenses, without grade classification, to engineers living in the city of Buffalo to the exclusion of nonresidents. . . . The complainant, it is true, had no positive right to a license to run a stationary engine, but he had a right, without respect to residence, to an examination as to his qualifications.

Uniform Boiler Laws for Canada—As a result of a conference held at the Parliament Buildings of the chief boiler inspectors of the different provinces, a uniform set of regulations is to be adopted for the entire Dominion to enable inspection in one province to be accepted in any other. At present Nova Scotia, New Brunswick and Manitoba have no regulations, although the necessary legislation has been passed.

D. M. Metcalfe, chief boiler inspector for Ontario, is chairman of the conference, and associated with him are: W. G. Mathieson, Nova Scotia; John Peck, British Columbia; R. M. Blackburn, Saskatchewan, and P. J. Jobin, Quebec. These men have been engaged revising the regulations and making such amendments as are necessary to bring those of the different provinces into uniformity, and Alberta, New Brunswick and Manitoba will adopt their recommendations when the work is completed.

Projected Canadian Power Plant—Announcement is made at Winnipeg that E. W. Backus, Minneapolis, Minn., has been granted water rights by the Ontario government on an understanding that he will develop 30,000 hp. on the Winnipeg River and erect a pulp mill at Kenora, Ont. It is contemplated that one-half of the power developed will be utilized by the mill.

Extend Service of Municipal Plant—Pasadena, Calif., has been given formal permission by the South Pasadena board of trustees to place conduits and pole lines in that city for the purpose of furnishing energy from the Pasadena municipal electric plant to the citizens of South Pasadena. Principally, the desire of General Manager Koliner is to furnish service to residents on the borderland between the two cities, but as time advances the demand may necessitate the extension of the service further into South Pasadena.

A Prize Competition has been opened to the employees of members of the Society for Electrical Development, Inc. The society offers eight prizes, $250, $150, $50 and five of $10 each, for the best story, article or report on any subject pertaining to "Commercial Electricity." The competition will close on Sept. 1. For full particulars address Competition Editor, Society for Electrical Development, Inc., 29 West Thirty-ninth St., New York City, and give name of employer.

Westinghouse Strike Ended—It has been officially announced by the Westinghouse companies that the Westinghouse strike at East Pittsburgh was called off by the workmen on Thursday, July 9. While the day set for their return to work was Monday, July 13, a large number of the men reported on the Friday and Saturday preceding. The works are now running full time.

Correction—In the articles describing the Hauto steam-electric power plant in the June 9, 16, 23 and 30 issues, through an inadvertence it was stated in the table of equipment that venturi meters were from the Builders' Iron Foundry Co., whereas they were furnished by the Simplex Valve & Meter Co., 112 North Broad St., Philadelphia, Penn.

NEW EQUIPMENT

ATLANTIC COAST STATES

The Department of Electric Light and Water, North Attleborough, Mass., is in the market for water-tube boilers. William Plattner is Mgr.

Bids will be received until Aug. 4, for constructing additions to the power house and for furnishing equipment for the Norfolk State Hospital, Foxboro, Mass., an engine, dynamo and switchboard will be required. W. Rodman Peabody is Chn. Bd. of Trustees.

Bids will soon be received by the Worcester State Asylum, Worcester, Mass., for a 72-in. by 21-ft. 6-in. horizontal tubular boiler, 94 tubes, 3½-in. by 20-ft. shell ½ in. thick, quadruple buttstrap riveted for the Grafton colony.

Plans are being prepared by Ewing & Chapelle, 101 Park Ave., New York, N. Y., for the erection of a central heat, light and power plant on Mohegan Ave., New London, Conn., for the Connecticut College for Women.

Bids will be received by Franklin W. Hooper, Secy. Bd. of Trustees, 30 Lafayette Ave., Borough of Brooklyn, New York, until 10 a.m., Aug. 8, for constructing a power house for the New York State School of Agriculture, near Farmingdale, N. Y.

The Tracy Development Co., Waterloo, N. Y., contemplates constructing a power plant at Waterloo. E. K. Baldwin is Secy.

SOUTHERN STATES

Bids will soon be received for the construction of a municipal electric-light plant, Winston-Salem, N. C. I. V. Turner is City Clk.

The Georgia School of Technology, Atlanta, Ga., will construct a power plant estimated to cost $200,000.

The Axton-Fisher Tobacco Co., Louisville, Ky., is erecting a new plant in which will be included a power plant. A dynamo and several motors ranging from 5 to 30 hp. will be installed.

The Purified Petroleum Products Co., Louisville Trust Bldg., Louisville, Ky., will soon be in the market for a 20-hp. motor.

CENTRAL STATES

Plans have been prepared by Ernest McGregor, Leader News Bldg., Cleveland, Ohio, for the construction of a power plant for the Parish & Bingham Co., 5363 Hamilton Ave., Cleveland.

Bids will be received until Aug. 7 for rebuilding the electric-lighting plant and water-works at Norwood, Ohio. The estimated cost is $62,000. Two boilers, two engines, an air compressor, two generators and a switchboard will be required. Walter G. Franz, Union Trust Bldg., Cincinnati, is the Engr.

The Munising Electric Light & Power Co., Munising, Mich., will soon construct a new power plant.

Bids will be received by M. J. Keating, Village Clk., Wauzeka, Wis., until July 28, for furnishing one 10-hp. gasoline-kerosene engine and one 5x8-in. triplex power pump.

WEST OF THE MISSISSIPPI

The Des Moines Electric Co., Des Moines, Iowa, will make extensions and improvements to its power plant, to cost $160,000. W. H. Thompson, Jr., Des Moines, is Gen. Mgr.

At a recent election the citizens of Lyons, Iowa, voted to issue bonds for the construction of a municipal electric-light plant.

F. M. Newland, Comr. of Water and Light, Topeka, Kan., has applied for a new unit in the power equipment. The estimated cost is $4500. C. B. Burge is City Clk.

The construction of an electric-light plant at Pilot Grove, Mo., is under consideration.

The Cisco Gas & Electric Co., Cisco, Tex., has been organized for the purpose of constructing an electric-light plant at Cisco. W. S. Michael is interested.

The Texas Southern Electric Power Co., Houston, Tex., has been incorporated to construct a power plant at Houston. Edwin B. Parker is interested.